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SOME PROBLEMS OF APPLIED SMALL MAMMAL SAMPLING IN WESTERN NORTH AMERICA

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The study of mammal populations is still a relatively new field. It is natural that most investigations have been pursued under selected conditions that introduce the fewest complications. At the same time, applied knowledge of mammal density and distribution has been a necessity in a number of fields. Applied needs differ in that problems which are encountered largely dictate the area and conditions under which a study is undertaken. Without minimizing the value of continued fundamental approaches it is appropriate that attention also be devoted to methods that are particularly adapted to special applications. It is important to Westerners that methods of population study have largely been developed by ecologists working in extensive areas of uniform vegetation. Modifications of sampling methods are often necessary where abruptly shifting terrain and vegetation is the rule, as is typical of Western conditions.

There is characteristically a striking variation in density and species composition of small mammals over small areas. Often these differences are between areas that appear to be fully equivalent. Further complications arise from the continuous variation between vegetation types so frequently found in areas of sharp relief. One may select distinct associations in which to trap, only to find that much of the surrounding area is intermediate in various combinations and will not be truly represented.

The main implication here is that a large and thorough population study on a single site, however valuable it may be in some aspects, will not provide estimates of density and species occurrence which may safely be interpolated over larger areas. Therefore an ecologist, given an area to census, and assuming his time and facilities are limited, is better advised to use smaller sampling units and cover a wider range of the habitat and its variation. Knowledge of the home ranges of the species encountered is essential to accurate density measurement. However, I should venture to suggest that the error would be smaller by approximating home range values and sampling broadly than by effecting greater precision on a single plot. Indexes of movement might be derived from rather limited trapping, using distances between successive captures. Another possibility is the technique of Morris (1955), who applied home range values

derived from one live-trapped grid to a number of simpler snap-trapped plots. Allowance must be made for the possibility that ranges may vary in different habitats or at different population densities.

I do not intend to dwell upon the relative merits of line and quadrat trapping; however, some comments are pertinent. Where extensive comparison of densities is required, or for short surveys, quadrats are often too laborious. There is much terrain in which a sizable quadrat would not fit. Where the quadrat size is kept small enough to be practical, many of its advantages are lost. Finally, quadrats are frequently unsuited to the specialized types of situations to be considered here. Similar thoughts have been expressed by others faced with sampling problems (e.g., Linduska, 1950).

The more simplified approaches to censusing are likely to yield only relative densities. Unless there are reasons for doing otherwise, it is probably wise to make this compromise at the outset, assuming that an adjustment for the effect of differences in home ranges can be made.

The principal objective of this discussion is to examine small mammal distribution in habitats which, because of their lack of uniformity, create sampling problems. I have attempted to classify the principal kinds of modification that may locally influence the distribution and abundance of small mammals.

1. Modifications within vegetation types
   - *A.* Modification of vegetation (differences in density, growth form or species) along streams, canyon bottoms, etc.
   - *B.* Significant openings, natural or through developments such as roads; result in margins of vegetation
   - *C.* Presence of widely dispersed vegetation elements, i.e., a tree or brush clump; extreme clumping of vegetation
   - *D.* Presence of widely dispersed features of terrain or ground cover—rock outcrops, logs, ponds, etc.
   - *E.* Physical deterrents such as streams, banks
2. Modifications involving different vegetation types
   - *A.* Distinct interfaces between vegetation types
   - *B.* Patches of one type within another
3. Influence due primarily to physical features or artificial habitat
   - *A.* Potential attractants such as refuse dumps
   - *B.* Restriction of area through surrounding cultivation or other development
   - *C.* Presence of buildings, etc.

The question is, will any of the conditions in the outline so affect the distribution of animals, or their movements in relation to traps, that the results of sampling will be seriously biased? Stated in another way, sampling methods assume random distribution of mammals. Such distribution is probably rarely encountered but the effect may not be significant in a reasonably uniform habitat. Is the distribution under the conditions outlined sufficiently nonrandom to significantly affect the results? At times the effect will be obvious, as with a river, highway, or some sharply contrasting vegetation types. Usually the effect is uncertain, causing a worker to question his results or to avoid the area altogether.

In order to explore the effects of certain of the habitat modifications given in the outline, test trapping was undertaken. Lines of live traps were used, consisting of 20 stations of three traps each, at measured intervals of 25 ft., set for three nights. They thus corresponded to the North American Census of Small Mammals line A. Animals were marked by toe-clipping and released. Densities were calculated using the successive recapture formula of Hayne (1949). The calculated densities generally approximate the total number of individuals captured. The similarity of these values suggested that nearly all animals available to the traps were usually captured. For this discussion the use of total individuals captured is more convenient. Comparisons of relative density between species based on total catch should be made with caution since distances of movement to the trapline may differ.

TRAPPING RESULTS

A site was chosen at La Panza Public Camp, in the La Panza Range, San Luis Obispo County, California, as an example of an interface between vegetation types and, to an extent, openings in the vegetation. Here a small canyon is present immediately behind the camping area (Fig. 1). On the south-facing slope there is chaparral of chamise, *Ceanothus cuneatus* and scrub live oak, with widely scattered large live oaks. The north-facing slope is blue oak woodland with

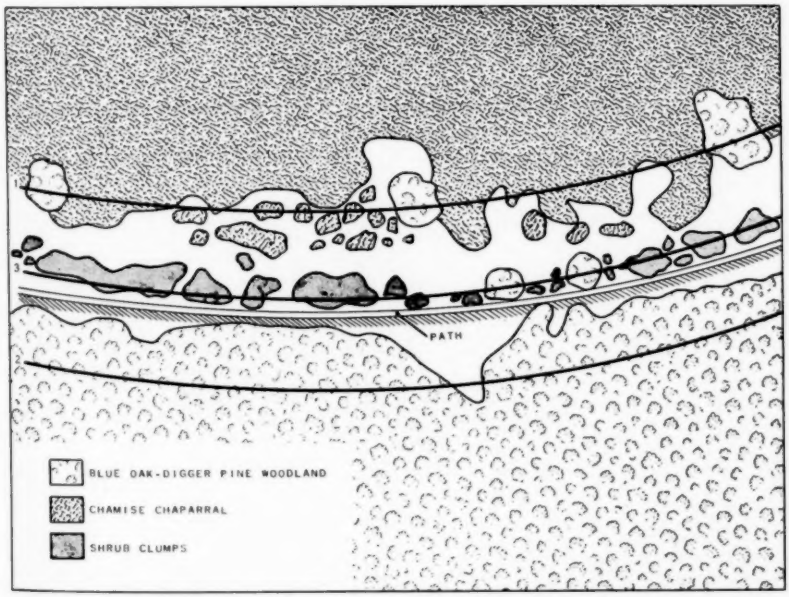

FIG. 1.—Trapping site at La Panza Public Camp, showing placement of live-trap lines. Distances between lines are 50 ft.

scattered digger pine and scattered growth of *Ceanothus, Rhus trilobata,* poison oak, and other shrubs. There is continuous grass cover on the slope. In a strip on the canyon bottom there are clumps of *Rhus trilobata,* poison oak, scrub oak, and buckwheat, affording dense cover with considerable open ground. Between the canyon bottom and the woodland slope is a path 4 ft. wide and a low sloping bank. On the chaparral slope, tongues of brush approach the bottom but there is much barren ground. Traplines were run on each slope, parallel to the canyon bottom and each 50 ft. from it. Line No. 1 ran partly along the lower brush edge, partly through tongues of brush. Line No. 2 was well within the woodland. After three nights these were removed and a single line (No. 3) placed along the canyon bottom. This approach was intended to minimize the interference of traps with the movements of animals.

TABLE 1.—*Numbers of rodents marked at La Panza Camp, San Luis Obispo County*

Line	*Peromyscus boylei*	*Peromyscus truei*	*Peromyscus californicus*	*Perognathus californicus*	*Neotoma fuscipes*	*Eutamias merriami*	*Microtus californicus*	Total mice, rats
1	13	9	7	9	6	0	0	44
2	14	0	0	2	5	9	0	21
3	16	2	5	12	4	0	1	40

Trapping was performed twice, in September, 1954 and in June, 1955. There was an apparent population increase in 1955, particularly of *Neotoma fuscipes* and *Peromyscus californicus.* However, the relationships between lines were essentially the same and present purposes are best served by combining the results. A total of 78 animals was marked involving 173 captures. The number of individuals marked per line is shown in Table 1, and their relationships to the lines in Table 2. The chipmunks showed avoidance of traps after their initial capture and are not included in the latter table. Bearing in mind that the distance between lines of 50 ft. is well within the daily range of these species, considerable restriction of movement between habitat segments is evident. No animals were taken on both lines 1 and 2; only 5 per cent crossed between lines

TABLE 2.—*Movements of rodents between lines at La Panza Camp, San Luis Obispo County*

	Peromyscus boylei	*Peromyscus truei*	*Peromyscus californicus*	*Perognathus californicus*	*Neotoma fuscipes*	Total
Individuals captured and available for transfer, lines 1 or 3	16	6	8	17	9	57
Individuals captured on both lines	10	1	4	7	1	23(40%)
Individuals captured and available for transfer, lines 2 or 3	22	1	5	10	5	40
Individuals captured on both lines	2	0	0	0	0	2(5%)

2 and 3 and 40 per cent between lines 1 and 3. It might be assumed that the reduced exchange between lines 1 and 3 was due to a number of individuals reaching the edge of their home range at line 1. However, the number marked and available from each line but not occurring on the other was exactly the same for each, 16 of 38 (42 per cent). Thirty-seven per cent of the animals captured on line 3 had not been taken on either other line. The significance of these restricted movements is emphasized by the following average distances between successive captures along separate lines: *Peromyscus truei* (5) 25 ft., *P. californicus* (13) 40.4 ft., *Perognathus californicus* (11) 18.2 ft., *Peromyscus boylei* (31) 17.9 ft. These movements occurred despite marked competition between trap stations, due to the short intervals of 25 ft.

A survey conducted at Grouse Creek in Mono County, 6 miles northwest of Sonora Junction at 9,000 ft., provides an example of an actual problem of sampling which was encountered. It was necessary to quickly assess the small mammal population of a bivouac area of the Marine Cold Weather Battalion, in connection with studies of human waste disposal. The relationship of mammals to the nearby stream was particularly important. Lines were placed as indicated in Fig. 2. Line 1 extended through sagebrush and unidentified dense evergreen shrub clumps of about equal coverage; line 2 along the stream through scattered dense clumps of willows and partly through edges of the aspen grove.

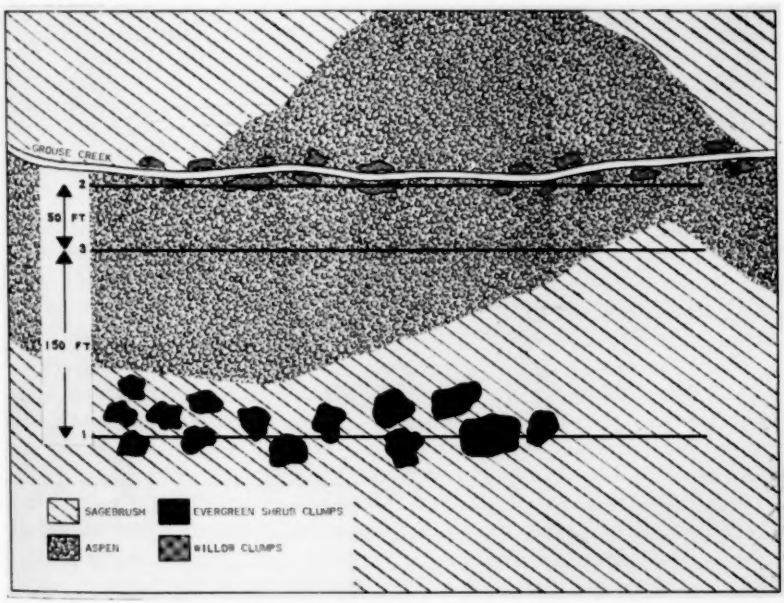

FIG. 2.—Trapping site at Grouse Creek, 6 mi. NW Sonora Junction, showing placement of live-trap lines.

Both were run concurrently for three nights. Line 3 was operated for the following three nights, running mainly through the aspen grove with intrusion of sagebrush, 50 ft. above line 2, 150 ft. from line 1. A separate line (No. 4) was run several hundred yards downstream through a sagebrush flat.

Comparison of distances between successive captures showed that *Peromyscus* and *Microtus* movements were about equal. Since the lines were not in strictly homogeneous vegetation, the catches do not adequately reflect the habitat distribution of the species (Table 3). *Microtus* occurred mainly in the dense shrub clumps on line 1 and willow clumps along the stream but avoided the aspen grove and to some degree, sagebrush. Supplementary trapping showed that *Microtus* numbers were low in areas where there was sagebrush alone. *Peromyscus* favored sagebrush and avoided the dense shrub clumps. However, a trapping program which sampled only uniform major habitats would have been inadequate to sample the animals in the actual area of concern.

TABLE 3.—*Numbers of rodents marked at Grouse Creek, 6 mi. NW Sonora Junction, Mono County*

Line	*Peromyscus maniculatus*	*Microtus longicaudus*	*Perognathus parvus*	*Eutamias amoenus*	Total
1	19	8	1	9	37
2	11	7	0	6	24
3	19	7	1	2	29

A single *Microtus* crossed 200 ft. from line 1 to line 2 (Table 4). Although lines 2 and 3 were only 50 ft. apart, fewer mice of either species were taken on both than on lines 1 and 3, which were 150 ft. apart. Thus, a line set along the stream would be drawing relatively few individuals from the aspen grove. The opposite is true of a line through the aspen. Chipmunks appeared to move freely between the brush clumps and the willows but spent little time in the aspen grove. Their over-all distribution in the area was decidedly limited.

A similar survey was made along a stream about 6 miles above Huntington Lake, Fresno County, at 8,400 ft. The area in general is lodgepole pine-red fir forest. The stream is about 2 or 3 ft. wide, bordered by dense, often large, but discontinuous patches of herbs and grass. There are scattered clumps of willow and gooseberry. Parallel lines were placed along one edge of the stream and 50 ft. up the opposite slope for three nights. During the following week these lines were moved to the opposite edge and slope for three nights.

Individual mice marked were five *Peromyscus maniculatus*, five *Microtus longicaudus*, seven *Zapus princeps*, with a total of 41 captures. The results are no more than suggestive. The *Peromyscus* and *Zapus* appeared to move freely across the stream and up the slopes. One *Microtus* crossed the stream and none were caught away from it. There were 16 mouse captures from one side of the stream, 8 from the other. Additional lines of 20 traps, spaced at 25-ft. intervals,

were set for single nights through nearby willow clumps, chaparral, and mixed aspen-chaparral. From six such lines only six *P. maniculatus* were caught, all in chaparral.

It is probable that the stream restricted the movements of *M. longicaudus*. The combination of circumstances caused a catch along one edge double that of the opposite edge, despite the free crossing of the other species. The over-all density of mice along the stream was considerably greater than in the surrounding area. Streams of various sizes must act as differential barriers to movements of different species. For instance, a larger stream might discourage crossing of *Peromyscus* but not *Zapus*, which freely enters the water. The potential effect on numbers sampled is considerable. The essentially linear distribution of species such as *Zapus* and *Microtus* along streams in forest profoundly modifies their area-wise distribution and abundance.

TABLE 4.—*Movements of rodents between lines at Grouse Creek, 6 mi. NW Sonora Junction, Mono County*

	Peromyscus maniculatus	*Microtus longicaudus*	Total
Individuals captured and available for transfer, lines 1 or 3	23	10	33
Individuals captured on both lines (distance 150 ft.)	9(39%)	4(40%)	13(39%)
Individuals captured and available for transfer, lines 2 or 3	14	9	23
Individuals captured on both lines (distance 50 ft.)	4(29%)	1(11%)	5(22%)

Of considerable importance is the effect of vegetation edge upon mammal populations. The principle of the "edge effect" has received attention, primarily in connection with birds and game animals. Here the assumption is made that a species has requirements found in two or more types of vegetation and will thus occur at the interfaces of these types. There are few indications of such requirements among the smaller mammals. However, there is an alternative possibility that an edge will represent habitat characteristics not possessed by either contributing habitat alone. An example is the narrow border of dense herbaceous growth which frequently is found along distinct edges of chaparral bordering grassland in coastal California. This sometimes is the sole area occupied by *Microtus californicus* in times of low density.

As a point of departure on this subject, I shall consider the work of McCabe and Blanchard (1950) on three species of *Peromyscus*. They found that in the Berkeley Hills, *P. maniculatus*, *P. truei* and *P. californicus* were not present in dense and continuous *Baccharis* chaparral, sclerophyll forest or eucalyptus groves, but occurred along the edges, particularly of chaparral. They concluded that "in this area *Peromyscus*, in short, is a creature of the chaparral edge

even more truly than most large 'forest' mammals are actually creatures of the forest edge. Its distribution is thus essentially linear." However, McCabe and Blanchard consider that any break or trail forms an edge. For *Peromyscus* to be an edge species, the chaparral must be defined as dense and continuous. A vegetation edge is usually thought of as an interface between types of vegetation, taking on special characteristics by virtue of this position, rather than an alteration of structure within an association. Making this distinction, the absence of animals in continuous dense chaparral may best be thought of as due simply to the absence of certain habitat requirements within it, while along the margins of such growth, these requirements exist. Extensive trapping in closely comparable chaparral of *Baccharis pilularis* in San Mateo County, with density of cover generally somewhat less than 100 per cent, has resulted in sizable catches of *Peromyscus maniculatus* dispersed throughout the vegetation. In dense woodland, however, the marginal distribution was confirmed.

An edge situation was sampled on a chaparral hillside one mile north of Coyote, Santa Clara County, California. The brush consists of black sage (*Salvia mellifera*) and coastal sagebrush (*Artemisia californica*) averaging about 80 per cent cover. A sharp but uneven edge is formed with lightly grazed grassland of moderate density. Lines of live traps parallel to the edge were run concurrently for three nights. On one, lying 50 ft. within the brush from the edge, were caught 14 individual mice captured 31 times: seven *Peromyscus truei*, six *Neotoma lepida*, one *Perognathus californicus*. The other line, 50 ft. into the grassland from the edge, caught nothing. On the succeeding three nights these lines were removed and one was set along the brush edge. In this line were taken six *P. truei*, one *N. lepida*, one *P. maniculatus*. Only the *P. maniculatus* had not been taken on the inner line. These results show no tendency for greater activity at the edge. It appears possible that *N. lepida* actually avoided the edge.

A separate line beginning at the brush edge, and extending perpendicularly into the same brush mass, yielded seven *Peromyscus truei*, two *Peromyscus californicus*, six *Neotoma lepida*, captured a total of 29 times. Again there was no tendency for animals to occur near the edge and, in fact, none was captured from the two trap stations at and adjoining the edge.

Another chaparral edge was investigated on Fossil Ridge, 1,600 ft., Mt. Diablo, Contra Costa County. Here there is primarily chamise and black sage, with scattered *Ceanothus cuneatus*. The cover averages from 70 to 90 per cent density. A sharp edge is formed with ungrazed grassland, one foot tall and fairly dense.

A different trapping technique was applied, consisting of four rows of trap stations perpendicular to the brush edge, with 100-ft. intervals between rows. In each row there were five stations 50 ft. apart, one at the edge, one in the grass and three extending into the brush. Again, there were three live traps per station. After one night in which all traps were set, alternate stations in each row through the brush and including the edge were set on six successive nights.

Those in the grass were operated continuously; after four nights they were moved to points 25 ft. from the edge.

There were 16 individual rodents, captured a total of 38 times. After the fifth night no new individuals were taken. From stations within the brush or at the edge were captured three *Perognathus californicus*, five *Peromyscus truei*, four *Neotoma lepida*, two *Neotoma fuscipes*. Among these, one *P. truei* was taken at two separate edge stations, another at one edge station, and both also occurred at inner stations. One *N. lepida* was captured a single time at an edge station. All other captures were within the brush. The average number of captures per station within the brush was 2.5, for stations at the edge, 1.2. At the stations in grassland, one *Mus musculus* was taken on the first night and not recaptured; one *Reithrodontomys megalotis* died in the trap on the second night. No animals caught in the brush appeared in the grassland traps.

In neither of the chaparral situations sampled did rodents favor the edges. Traplines placed along the edges captured about half as many individuals as did those within brush, as might be expected. There are implications here for collectors who assume, not inconveniently, that a better catch is to be obtained along a vegetation edge. Linduska (1950) found no tendency for *Peromyscus maniculatus bairdi* to favor edges of various farm habitats in Michigan. It is significant that none of the rodents caught in the brush were taken in grassland stations, even at a distance of 25 ft.

From this limited survey there is no indication that the edge effect is in effect for small rodents. The marginal distribution described by McCabe and Blanchard (1950) appears to be a specialized condition rather than the rule. Where it occurs it causes an important modification from random distribution. The over-all density of rodents in a given area might be profoundly influenced by the extent of continuous dense shrub or tree vegetation.

DISCUSSION

In each of the situations trapped there was evidence of nonrandom distribution of the animals in relation to the traplines such that small differences in placement of traps in these areas could seriously alter the results. Two factors contribute to this nonrandomness: (1) There may be differences in actual density and species occurrence in different habitat segments; (2) movements of individuals in relation to traps may be affected, altering the catch and giving a biased estimate of density. Various combinations of habitat modifications given in the outline appear to have been involved in the areas sampled. At La Panza Camp there was a partly separated interface between chaparral and woodland. The favored habitat of *Peromyscus truei* was probably almost limited to the main body of chaparral. *Peromyscus californicus* and *Perognathus californicus* may have found the rather open woodland unsuitable. The relatively low density of mice in the woodland is typical of that habitat. Other restrictions of movement between lines may have been due to reluctance of individuals to cross openings in vegetative cover. The effect of these restric-

tions is such that a line down the canyon bottom would give a strongly biased estimate, since the animals living in the brush strip are limited in their movements, yet numerous, and those from the chaparral and woodland slopes contribute relatively few individuals to the line.

At Grouse Creek, restrictions of movement seemed to result from contrasts in habitat segments, with the difference between willow-streamside and aspen the more effective deterrent. Above Huntington Lake, the stream appeared to limit *Microtus* crossing and provide an example of a streamside fauna contrasting sharply in species and density with the surrounding forest. Sampling along brush edges showed no effect on the animals except that they did not extend into the adjoining grassland. However, where the marginal distribution described by McCabe and Blanchard (1950) occurs with very dense vegetation, it provides a good example of a habitat modification given in the outline.

The restriction of movement of individuals may be physical, as with a stream. To an unknown degree it may result from psychological factors involved in habitat selection. This influence might even have the effect of holding a given individual to a certain habitat type when an adjoining type is occupied by other members of the species. Such subtleties, if they exist, must be finely interrelated with the effects of the presence of other species.

The occurrence of animal species has traditionally been expressed as geographic range, often with a qualitative habitat evaluation, or as a density measurement considered representative of a given habitat type. Blair (1951) pointed out that "No adequate measurement and analysis of population densities throughout the range of even a single species has yet been made." He discussed the problem of geographic variation in density, emphasizing its mosaic nature and the linear distribution of many species along streams. Certainly any advance in this significant area of investigation will require consideration of the various modifications of distribution discussed above and the development of sampling methods suited to them. Perhaps the most fruitful method will be the use of vegetation maps in which all habitat segments that may involve significant population differences are distinguished (see Küchler 1956). After adequate sampling to represent each segment type, expressions of density might be superimposed on the map.

SUMMARY

Methods of small mammal population study have generally been suited to extensive areas of uniform habitat. Where the terrain and vegetation are varied and abruptly changing, modified sampling methods are required. Several smaller sampling units rather than one large quadrat may be needed to evaluate the variation in mammal occurrence.

Trapping was undertaken to evaluate the effect of various habitat modifications upon small mammal distribution and movements, such that sampling would be biased. Lines of live traps corresponding to the North American Census of Small Mammals line *A* were employed for three-night periods in which animals were marked and released. A small canyon in the central coast

range of California was sampled where one slope bore chaparral, the other oak woodland and there was a strip of brush in the canyon bottom. There were distinct differences in species and density of rodents taken from parallel lines 50 ft. apart on each slope and in the canyon bottom. Movements of animals between lines were restricted and none were found to cross from one slope to the other.

At a site in the Sierra Nevada in Mono County, a line was placed along a willow-lined creek and two parallel lines were run at distances from it of 50 and 150 ft. through aspen and sagebrush, respectively. More rodents were found to have moved between the lines 150 ft. apart than between those 50 ft. apart. A restriction of movement toward and away from the stream was indicated. Trapping along another stream in the Sierra showed that the stream probably restricted the crossing of *Microtus longicaudus* but not of *Peromyscus maniculatus* and *Zapus princeps*.

Trapping was performed along two sharply defined edges of chaparral bordering grassland. There was no evidence that rodents favored the edges over the body of the brush and none were captured in the grass. This result contrasts with the finding of McCabe and Blanchard (1950) that *Peromyscus* favors the margins of dense and continuous *Baccharis* chaparral in the San Francisco Bay area. It is concluded that this reflects the absence of habitat requirements in dense growth rather than a preference for the edge as such.

It is concluded that in each area trapped there was evidence of influences upon the distribution of animals and their movements in relation to the traps which would bias a sampling result. There is need for analyzing the distribution and variation of population densities. Such an analysis will require consideration of the modifications of distribution discussed in this paper.

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California Dept. of Public Health, Berkeley. Received September 6, 1956.

THE LOWER DENTITION OF *MEPHITITAXUS ANCIPIDENS* FROM THE FLORIDA MIOCENE

By Stanley J. Olsen

When Dr. T. E. White (Proc. New England Zool. Club, 18: 91–98, 1941) erected the genus *Mephititaxus* he based the differences between this genus and the related genus *Leptarctus* on the characters of M^1. A re-examination and comparison of the type of *M. ancipidens* with casts of the types of *L. oregonensis*, *L. primus* and the type of *L. progressus* indicates that there is as much difference among these related species as between *Mephititaxus* and *Leptarctus*. Although *M. ancipidens* is considerably larger when compared with the known Leptarctines, it is certainly within the size variation found in the comparable living genus *Martes*.

With the material now at hand, and until such time as a more extensive comparison can be made, I am referring the described material to the genus

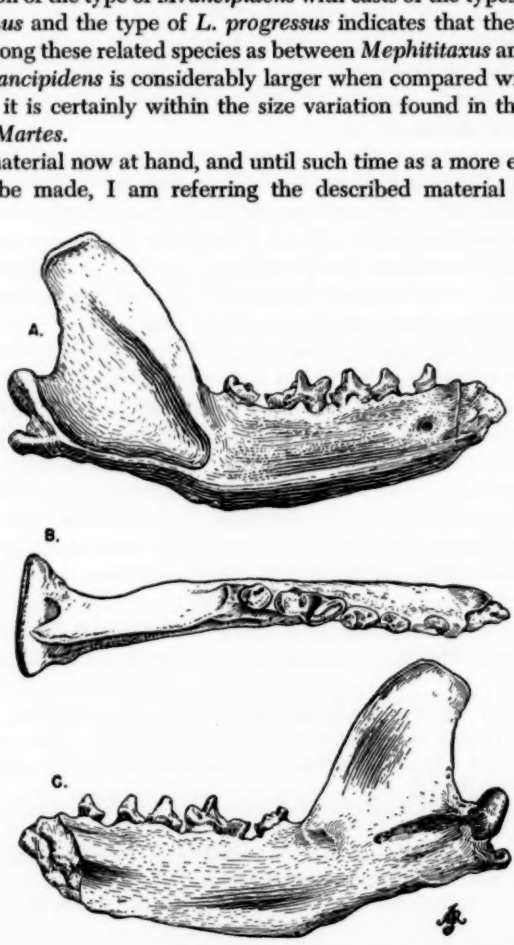

Fig. 1. *Mephititaxus ancipidens*, V–5655, × 1. *A*, labial, *B*, occlusal, *C*, lingual views of right mandible.

Mephititaxus with the reservation that additional new material may bring about the abolition of this genus so as to include the species *ancipidens* in *Leptarctus*.

Referred material.—F. G. S. V-5655 (Fig. 1), right mandible with P_1–M_2; F. G. S. V-5654 (Fig. 2), left M_1.

Horizon and locality.—Lower Miocene, Thomas Farm, Gilchrist County, Florida.

Description.—Taking into consideration that the described lower jaw and dentition are almost certainly not of the same individual from which the type description was made, the two specimens occlude as well as two individuals of the same species and size found in a living related genus.

The mandible of *M. ancipidens* is two-thirds larger than that of the type of *Leptarctus primus* but agrees with this similar form in the general construction and proportions of the carnassial and premolars. The second, third and fourth premolars are double-rooted and compressed laterally but are not crowded or set obliquely to the long axis of the jaw. P_4 has a well-developed posterior accessory cusp on the postero-external face of the tooth. A well-defined cingulum is present on the heel of this last premolar. The teeth in general and M_1 in particular show considerable wear (Fig. 1) so that an unworn specimen of the lower carnassial (Fig. 2) has been used for the description of this diagnostic tooth.

In M_1 the protoconid is well-defined with the paraconid and metaconid being of equal size but not nearly as high as the protoconid. The peak of the metaconid is located just posterior to that of the principal cusp. The talonid is basined, exhibiting a distinct hypoconid, hypoconulid and entoconid along a well-defined rim. A strong crest or ridge, which is not present in *Leptarctus primus*, connects the entoconid and hypoconid. The shear of the carnassial is nearly antero-posterior.

M_2 is double-rooted and is pitched forward and downward due to its position in relation to the ascending ramus. The metaconid and protoconid are of equal size and placed equidistant from the anterior edge of the tooth. The hypoconid is present and not submerged in the heel.

The mandible has the heavy proportions and relative depth of ramus of the genus *Taxidea*. The lower surface of the jaw makes a decided angle, the vertex of which lies just below the anterior border of the masseteric fossa and extends up to and beyond the articular condyle. The angular process is well-developed and directed postero-medially.

FIG. 2. *Mephititaxus ancipidens*, V–5654, × 2. *A*, labial, *B*, occlusal, *C*, lingual views of left M_1.

A more intensive search of the boulder bar area of the Thomas Farm quarry may in the future yield additional material of this interesting Miocene carnivore and help in establishing its generic position.

Florida Geological Survey, Tallahassee, Florida. Received August 27, 1956.

REVIEW OF THE LONG-NOSED BATS OF THE GENUS *LEPTONYCTERIS*

By Donald F. Hoffmeister

Long-nosed bats (*Leptonycteris*) are known to occur from southern Arizona and southern Texas through much of México, and again in parts of Guatemala and the Netherlands Antilles (formerly Dutch West Indies). Little is known of the habits of these bats. In the northern part of their range, large numbers of female *Leptonycteris* congregate together in "nursery" colonies where young are born in midsummer. These colonies may be found in caves, mines, or unused buildings. In southern México (Guerrero), adults of both sexes are known to inhabit caves in late summer. Long-nosed bats feed on nectar, pollen, and insects. Many of the insects are probably picked up as the bats are gathering nectar and pollen from within flowers.

Long-nosed bats from southeastern Arizona have been known to differ rather markedly from others in southern Texas (see Hoffmeister and Goodpaster, 1954; Sanborn, 1941). This has prompted a systematic review of *Leptonycteris* throughout the range of the genus. When I started this work some years ago, I learned that Colin C. Sanborn had previously inaugurated such a study but had abandoned it. With his blessing, he turned over to me the information he had assembled, and this has proved most useful in the study. I am most appreciative of his kindness in this regard. Many of his original ideas have aided me in this work, but the conclusions arrived at should be regarded as my responsibilities.

The present study indicates that within the genus *Leptonycteris* there are three geographical races worthy of subspecific designation whose ranges are:

Leptonycteris nivalis nivalis (Saussure) from the Chisos Mountains of Texas through eastern México, but mostly east of the 102° meridian, south at least to Guerrero, and then again in Guatemala.

Leptonycteris nivalis sanborni new subspecies, from Pima County, Arizona, south through western México, mostly west of the 102° meridian.

Leptonycteris nivalis curasoae Miller, from Curaçao and Aruba islands, Netherlands Antilles (Dutch West Indies).

[Since this manuscript was sent to press, another subspecies has been described (Stains, 1957). To make this revision complete, the new form is inserted herein, without critical study: *Leptonycteris nivalis longala* Stains from the Chisos Mountains of Texas to southern Coahuila. This represents the northern part of the range ascribed above to *L. n. nivalis*.]

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In the *Measurements*, the average is followed in parentheses by the minimum and maximum measurements. All are given in millimeters. Since males and females are so nearly the same in size, the two sexes are averaged together in some cases.

Genus LEPTONYCTERIS Lydekker

Leptonycteris Lydekker, *in* Flower and Lydekker, An introduction to . . . mammals . . ., London: Adam and Charles Black, 1891, p. 674. Type: *Ischnoglossa nivalis* Saussure.

Diagnosis.—An American leaf-nosed bat (Phyllostomidae) of the subfamily Glossophaginae in which the tail is so shortened as to appear externally to be lacking but actually consists of three caudal vertebrae; size large, the head and body length, 70 to 95 mm.; forearm, 46 to 57 mm.; rostrum and snout greatly lengthened but less elongate than in some other glossophagines; lower incisors present; first phalanx of third finger less than one-third the length of the metacarpal; dental formula, $\frac{2}{2}\frac{1}{1}\frac{2}{3}\frac{2}{2}$. In some cases, the lower incisors may be so worn down as to appear to be absent or they may become entirely lost.

Leptonycteris nivalis sanborni new subspecies

Type.—Adult female, No. 3888, University of Illinois Museum of Natural History, skin and skull; mouth of Miller Canyon, Huachuca Mountains, 10 mi. SSE Fort Huachuca, Cochise County, Arizona; collected August 18, 1950, by Donald F. Hoffmeister, original No. 1444.

Range.—Southeastern Arizona (Pima and Cochise counties) and possibly southwestern New Mexico, southward in western México, in or near the Sierra Madre Occidentál and west of the Chihuahuan Desert, south to east-central Michoacán.

Diagnosis.—A race of *Leptonycteris nivalis* characterized by size small; color of underparts heavily washed with brown or cinnamon; three phalanges of third finger have total length equal to or less than length of third metacarpal; forearm short, especially in northern populations, averaging less than 53.5 mm.; skull short, greatest length averaging less than 27.0 mm. and condylobasal length usually 26.2 mm. or less; upper toothrow, from canine to last molar, usually less than 9.0 mm.; color of dorsum usually reddish brown.

Comparisons.—*L. n. sanborni* differs from *L. n. nivalis* as follows: length of three phalanges of third finger not greater, on the average, than length of third metacarpal; size smaller, the length of the head and body averaging as much as 10 per cent less at comparable latitudes; forearm shorter; skull short, with greatest length averaging less than 27.0 mm.; condylobasal length averaging 26.2 mm. or less; upper toothrow shorter, with the length from the canine to the last molar usually under 9.0 mm. rather than more; color of underparts more brownish or cinnamon and dorsum more reddish; bright brown individuals, which may represent a brown color phase, are more prevalent in *sanborni* than in *nivalis*.

L. n. sanborni differs from *L. n. curasoae* as pointed out in the description of the latter subspecies.

Measurements.—External measurements of 22 (unless otherwise indicated) adult females from the type locality are: total length, 77.6 (69–84); hind foot, 15.0 (13–17); ear from notch, 16.0 (14–18); forearm, for 10 specimens, 53.0 (51.3–54.3); third metacarpal (including carpal), for 18 specimens, 49.1 (47.7–52.7); total of three phalanges of third finger, for 18 specimens, 47.3 (44.8–52.4). Average measurements of 10 adult males from Carimechi, Río Mayo, Chihuahua, are: total length, 76.2; hind foot, 13.9; forearm, 53.0; third metacarpal (including carpal), 49.6; total of three phalanges of third finger, 48.7. Eight adult males from Hacienda Magdalena, Colima, average: third metacarpal (including carpal), 49.2; total of three phalanges of third finger, 48.7.

Cranial measurements of 21 (unless otherwise indicated) adult females from the type locality are: greatest length, for 18 specimens, 26.7 (25.7–27.3); condylobasal length, 25.7 (25.1–26.4); interorbital width, 4.6 (4.4–4.9); palatal length, 14.6 (14.0–15.1); mastoidal width, for 20 specimens, 10.4 (10.0–10.8); width of braincase, for 19 specimens, 9.9 (9.6–10.2); length from upper canine to last molar, for 17 specimens, 8.8 (8.4–9.1).

Remarks.—*L. n. sanborni* is a small subspecies, with small wings, small skull, and bright color. Nearly all specimens can be distinguished from the other subspecies by a combination of characters. One characteristic alone, namely that of length of the three phalanges of the third finger being less than the length of the third metacarpal, serves to distinguish most individuals from *L. n. nivalis.*

In the northern part of the range of the species, *L. n. sanborni* seems to be separated from *L. n. nivalis* by the more arid parts of Chihuahua and Durango. However, in the southern part of the range, in Michoacán, the two subspecies come together with complete intergradation. Within the range of *L. n. sanborni,* the populations are rather uniform except for that at San Sebastián, Jalisco. In many respects, specimens from there are similar to *L. n. nivalis.*

*Specimens examined** or recorded and measured by Colin Sanborn† (*in litt.*) but not seen by me: **Arizona:** *Cochise Co.*: Colossal Cave, 30 mi. SE Tucson, 2* (U.S. Biol. Serv. Coll.); 10 mi. NW Paradise, 4* (Coll. W. Gene Frum); mouth of Miller Canyon, Huachuca Mts., 56* (Univ. Illinois); Canelo Mine, 8 mi. W Ft. Huachuca, 6* (Univ. Illinois). **Sonora:** Pilares, 8* (Univ. Michigan); Santa María Mine, El Tigre Mts., 3* (Univ. Michigan). **Chihuahua:** Río Mayo, Carimechi, 24* (Univ. Michigan). **Sinaloa:** Escuinapa, 6† (Amer. Mus.). **Nayarit:** Acaponeta, 300 ft., 1* (U.S. Biol. Surv. Coll.). **Jalisco:** Balaños, 1* (U.S. Biol. Surv. Coll.); San Sebastián, 3,300 to 7,000 ft., 4* (U.S. Biol. Surv. Coll.); 5 mi. W Chapala, 5,000 ft., 2* (Coll. W. Gene Frum); Los Masos (not plotted), 1† (Amer. Mus.); Santa Ana Acatlán, 2† (British Museum). **Colima:** Hacienda Magdalena, 8* (Chicago Nat. Hist. Mus.). **Michoacán:** Lake Chapala, 1† (Amer. Mus.); Pátzcuaro, 1* (Chicago Nat. Hist. Mus.); 12 mi. (on Huetamo Road) south of Tzitzio, 1* (Univ. Michigan).

Leptonycteris nivalis nivalis (Saussure)

M [=*Ischnoglossa*] *nivalis* Saussure, Rev. Mag. Zool., Paris (2), **12**: 492, 1860.

Leptonycteris nivalis Miller, Proc. Biol. Soc. Washington, **13**: 126, 1900.

Leptonycteris nivalis yerbabuenae Martinez and Villa, Ann. Inst. Biol. Univ. Nac. Mexico, **11**: 313, 1940. Type from Yerbabuena, Guerrero, México.

Type.—Sex not known to me, No. 515/97, Museum d'Histoire Naturelle de Genéve, Switzerland, originally skin and skull; now, skull only; near the snow line on Mount Orizaba, Veracruz, México; obtained by Henri de Saussure.

Range.—Southwestern Texas (Brewster County) southward in central and eastern México, east of the Sierra Madre Occidentál, south to Guerrero, and in Guatemala.

Diagnosis.—Size large; color of underparts less heavily washed with brown; three phalanges of third finger with a total length usually greater than length of third metacarpal; forearm long, averaging in northern populations 58.5 mm.; skull long, greatest length averaging more than 27.0 mm. and condylobasal length more than 26.2 mm.; upper toothrow, from canine to last molar, usually 9.0 mm. or more; color of dorsum more sooty brown.

Comparisons.—*L. n. nivalis* differs from *L. n. sanborni* as described in the account of the latter.

L. n. nivalis differs from *L. n. curasoae* as described in the account of that subspecies.

Measurements.—Skull of the type specimen: greatest length, 28.2; condylobasal length, 27.5; palatal length, 14.8; tympanic width, 12.0; width of braincase, 10.9; alveolar length from upper canine to last molar, 9.0. One specimen from Orizaba (Chicago Nat. Hist. Mus.) has a forearm of 54.4; third metacarpal, 49.9; total of three phalanges of third finger, 49.2.

Measurements of 14 adults (6 males, 8 females) from Chisos Mountains, Texas, are: total length, 85.4; forearm, for 32 specimens, 58.5; third metacarpal (including carpal), for 9 specimens, 53.4; total of three phalanges of third finger, for 9 specimens, 61.4; greatest length of skull, for 11 specimens, 28.1; condylobasal length, for 11 specimens, 26.9; interorbital width, 5.3; palatal length, 15.0; mastoidal width, 11.7; width of braincase, 10.7; upper canine to last molar, 9.0.

In 40 adults (11 males, 29 females) from Cerro Potosí, Nuevo León, the third metacarpal averages 53.0; total of three phalanges of third finger, 61.8. Judging from Martinez and Villa's description (1940) of *yerbabuenae*, in males the third metacarpal is 49.1; three phalanges, 55.0; in females, third metacarpal, 50.5; three phalanges, 56.6.

Remarks.—*L. n. nivalis* is a large form, with long wings and the color on the dorsum usually a sooty brown rather than a bright brown. In the southern part of its range, *nivalis* intergrades with *sanborni*. The type locality of *nivalis* (Mt. Orizaba) is toward the southern part of the range of the subspecies. However, judging from the skin and skull in the Chicago Natural History Museum labeled

as Orizaba and the measurements of the skull of the type, these specimens in Veracruz should be associated with the large, long-winged subspecies. Specimens from the state of Guerrero, as at 12 mi. S Mexcala and Yerbabuena, the type locality of *L. n. yerbabuenae* Martinez and Villa, are more closely associated with the larger form, *L. n. nivalis*. Until recently, we have had only Martinez and Villa's description of *yerbabuenae* since specimens were not in existence. However, Mr. Luis de la Torre obtained a topotype of *yerbabuenae* which aids in demonstrating that *yerbabuenae* closely resembles *L. n. nivalis*, of which the latter is the earliest name. De la Torre has already pointed this out (1955).

The specimens from Guatemala in the British Museum were not seen by me but examined and measured by Colin Sanborn. They are only tentatively, on the basis of his measurements, referred by me to *L. n. nivalis*.

In 1952, Dr. Pierre Revilliod of the Museum d'Histoire Naturelle de Genève examined the type of Henri de Saussure's *Ischnoglossa nivalis* and indicated that it now consists of a skull only. The measurements of the type are those provided by Revilliod.

*Specimens examined** or recorded and measured by Colin Sanborn† (*in litt.*) but not seen by me: **Texas:** *Brewster County*: Mount Emory, Chisos Mts., 56* (Chicago Nat. Hist. Mus.). **Nuevo León:** Cerro Potosí, near La Jolla, Galena, 80* (Chicago Nat. Hist. Mus.). **Michoacán:** Queréndaro, 5,800 ft., 2* (U.S. Biol. Surv. Coll.). **Veracruz:** Orizaba, 1* (Chicago Nat. Hist. Mus.). **Distrito Federal:** Cave El Feuhtle, 1* (U.S. Biol. Surv. Coll.). **Morelos:** 600 m. SW Huajintlán, 1,050 m., 1* (Univ. Illinois). **Guerrero:** 12 mi. S Mexcala, 1* (Chicago Nat. Hist. Mus.). **Guatemala:** Dueñas, 1† (British Museum); Ciudad Vieja, 1† (British Museum).

Leptonycteris nivalis longala Stains

Leptonycteris nivalis longala Stains, Univ. Kans. Publ., Mus. Nat. Hist., **9:** 355, 1957.

Type.—Adult female, No. 33087, Univ. Kansas Mus. Nat. Hist., skin and skull; 12 mi. S and 2 mi. E Arteaga, 7,500 ft., Coahuila; collected July 11, 1949, by W. K. Clark, original No. 787.

Range.—Chisos Mountains, Brewster County, Texas, southward to southern Coahuila.

Remarks.—The describer characterizes this form as large sized, long fingered (especially the third finger), and pale colored, with a large, broad skull.

In my interpretation of the race *L. n. nivalis*, specimens from the Chisos Mountains of Texas and the Cerro Potosí of Nuevo León (now assigned to *longala*) are regarded as more nearly typical of the geographic race *nivalis* than are topotypes, near the southern part of the range, which exhibit intergradation with *sanborni*. One must evaluate both *L. n. longala* and *L. n. nivalis* in light of this.

Leptonycteris nivalis curasoae Miller

Leptonycteris curasoae Miller, Proc. Biol. Soc. Washington, **13**: 126, 1900.

Type.—Adult male, No. 101851, U.S. National Museum; skin in alcohol, skull removed; Willemstad, Curaçao, West Indies (now Netherlands Antilles); obtained by Leon J. Guthrie, November–December, 1899.

Range.—Curaçao and Aruba islands, Dutch West Indies (see Sanborn, 1943: 276).

Diagnosis.—Size small, as small or smaller than *L. n. sanborni;* color unknown as available specimens are preserved in alcohol or skins are made from specimens preserved in formalin; wing short, three phalanges of third finger shorter than third metacarpal and forearm short; skull of large size for southern population (tend to be large in the north, small in the south); upper and lower teeth large, and as a result, space between teeth less.

Comparisons.—*L. n. curasoae* differs from *L. n. nivalis* as follows: teeth larger, particularly the incisors and premolars, and as a result less spacing or gaping between teeth; length of upper toothrows slightly greater; three phalanges of third finger less than length of third metacarpal.

L. n. curasoae differs from *L. n. sanborni* in much the same way it differs from *L. n. nivalis* with regard to the size of the teeth.

Measurements.—External measurements of the type (made by C. C. Sanborn) and three males (all topotypes) are, respectively: forearm, 53.3, 53.6, 53.5, 55.0; third metacarpal (including carpal), 49.0, 51.1, 50.3, 51.0; total of three phalanges of third finger, 49.5, 48.5, 48.5, 50.4. Cranial measurements of the type and two topotypes are, respectively: greatest length, 26.4, 27.8, 27.8; condylobasal length, 25.0, 26.5, 26.4; interorbital width, 4.5, 5.2, 5.0; palatal length, 14.7, 15.4, 14.8; mastoidal width, 10.4, 10.4, 10.5; width of braincase, 9.9, 9.8, 9.9; upper canine to last molar, 9.0, 9.5, 9.5.

Remarks.—This form is so closely allied with the species *L. nivalis* that it is here regarded as a subspecies. Such salient features as incisors equally spaced in *curasoae* can nearly be matched in many specimens of *L. nivalis* from México where the four incisors are more nearly in two pairs separated by a distinct gap. Furthermore, the larger size of the incisors may cause them to be more equally spaced. The feature of lower Pm_2 (actually the first premolar in the series) being distinctly crescentic in *curasoae* is true, but is not diagnostic for it is of the same shape in many specimens of *L. n. nivalis* and *L. n. sanborni.* In *curasoae* the teeth are heavier and longer (anteroposteriorly) with less space between the individual teeth, and in this regard differ most strikingly from other *L. nivalis.* The color of the pelage of *curasoae* cannot be described as all specimens have been in alcohol or formalin. The interfemoral membrane looks no narrower or no less hairy than in other *nivalis.* It seems best to regard *curasoae* as a subspecies of *L. nivalis.*

Specimens examined: **Curaçao, Netherlands Antilles:** Willemstad, 2 (U.S.

Nat. Mus.); northwest end of island, 1 (U.S. Nat. Mus.); southwest side of island, 1 (U.S. Nat. Mus.); Cueba Bosá E., 2 (Rijksmuseum Nat. Hist., Leiden).

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COLOR VARIATION AND MOLT IN *TADARIDA BRASILIENSIS* AND *MYOTIS VELIFER*

BY DENNY G. CONSTANTINE

Previous treatment of color variation in practically all species of bats has been quite arbitrary, with no consideration of molt and subsequent changes in color. The present paper attempts to interpret certain heretofore undescribed aspects of color variation in *Tadarida brasiliensis mexicana* (Saussure) and *Myotis velifer incautus* (J. A. Allen), necessarily describing the time and sequence of molting. Indications are that once each year adults of both species molt into a fresh, dark-colored coat, and this coat eventually fades or bleaches to a markedly lighter color.

Molting specimens were designated as such by direct observation, confirmed by microscopic examination of cleared skin and skin sections, which showed that old pelage areas were invaded by the pigmented follicles and early growth stages of new hair. Live bats were examined to provide a quantitative check on interpretations, which are based on skins. Specimens were designated as immature when they showed combinations of small size, lack of fusion of epiphyses of finger joints, incomplete cranial development, and little or no tooth wear. Color assignments are from Ridgway (COLOR STANDARDS AND COLOR NOMENCLATURE, Washington, 1912).

Tadarida brasiliensis mexicana (Saussure)

Specimens examined in this study are from all parts of the recognized geographical range of the subspecies except Nevada, Utah, Colorado and the northwestern mainland of Mexico.

Molt.—One hundred and thirty molting adults were examined, and all were collected in summer and fall. Of 878 *Tadarida* collected at Frio Cave, Uvalde

County, Texas, during July, 1948, 90 per cent were females; 98 per cent of the females were in old pelage, and the remainder were molting. One per cent of the males were in old pelage, 95 per cent were molting, and 4 per cent were in fresh pelage. During August, 1944, 17 female *Tadarida* were collected at Frio Cave. Two were in faded pelage and the others were molting. These data suggest that males begin molting earlier than females. This schedule is in agreement with specimens from other parts of the geographical range. The latest molting specimens were two females collected by Bryan P. Glass and John F. Sage in September in a cave near Freedom, Oklahoma. This evidence indicates that the period during which molt occurs may be between early July and late September. The young are born devoid of pelage; however, they soon acquire a coat by a sequence apparently unrelated to the adult molt pattern. The adult molt pattern is illustrated in Fig. 1.

General distribution of pigment in hair.—Dorsum: Hairs generally a dark shade with whitish bases, infrequently with light buff tips; a sprinkling of white hairs commonly occurs. Venter: Same color and distribution as dorsum except hair tips are light buff. Only the dark color will be assigned, because this color is dominant and is represented on both dorsal and ventral surfaces.

Fresh coat.—The fresh adult coat is usually sepia, but varies from mummy-brown through sepia to olive brown. It appears to be the same throughout the geographical range.

Faded coat.—Fading is first evident in spring. In the northern and western

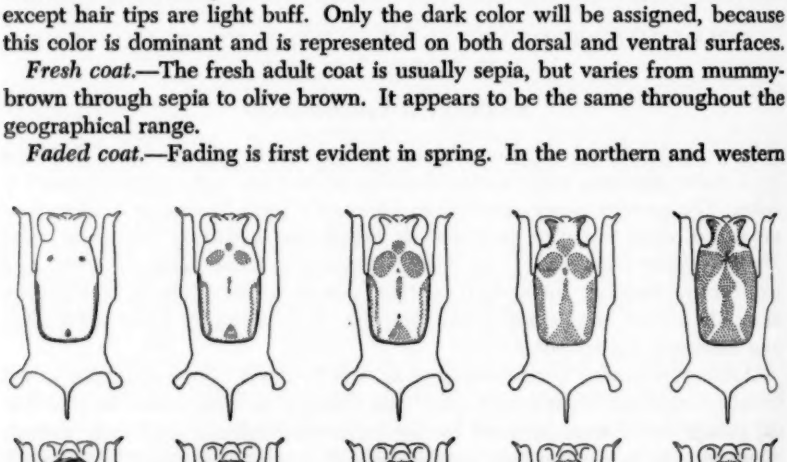

FIG. 1.—Molt pattern of *Tadarida brasiliensis mexicana*. Upper row: dorsal view. Bottom row: ventral view. The fresh pelage appears in stippled areas. Early stages are at left, late stages at right. The dorsal surface is almost completed before molt begins on the venter.

parts of the range the faded pelage is usually bister, sometimes slightly paler. However, from southeastern New Mexico and northwestern Oklahoma southward, including all but the Pacific coast of Mexico, a more reddish hue—a color between Prout's brown and cinnamon brown—is evident. In contrast, practically all faded specimens from Frio Cave are an intense cinnamon brown, and the faded specimens from Ney Cave, Medina County, Texas, are Sayal brown. Three specimens, representing two other collecting stations, are also excessively light. One of these, similar to Ney Cave specimens, was collected by Byron Walker at Meade County State Park, Kansas. Near Edith, Oklahoma, Herbert E. Warfel collected two specimens similar to those found in Frio Cave.

Coat of young.—The fresh pelage of immature specimens is usually mummy-brown, but it has the same color range as the fresh adult coat.

Specimens examined.—From the following localities, 4,718 specimens were examined. *Arizona*: Ft. Mojave, 2 skins; Tucson, 3 skins; Chiricahua Mts., 4 skins; Palo Verde, 5 skins; San Francisco Mt., 1 skin; Ehrenburg, 1 skin; Lower Eagle Creek Cave, 13 skins, 175 live; Willcox, 8 skins, 67 live. *California*: Fresno, 6 skins; San Jose, 14 skins; Winterhaven, 1 skin; Anguin, 1 skin; Palm Springs, 1 skin; Pinole, 2 skins; San Bernardino, 3 skins; Dulzura, 1 skin; Santa Barbara, 1 skin; Culver City, 2 skins; Loma Linda, 1 skin; Pasadena, 2 skins; Acton, 2 skins; Porterville, 5 skins; Santa Cruz Island, 1 mummy; Little Lake, 1 skin; Oakland, 2 skins. *Kansas*: Medicine Lodge, 4 skins; Lincolnville, 1 skin; Castle Rock, 1 skin; Meade County State Park, 1 skin. *New Mexico*: Carlsbad Cavern, 7 skins; Berino, 2 skins; Las Cruces, 1 skin; White Sands, 1 skin; Albuquerque, 2 skins. *Oklahoma*: Enid, 1 skin; Stillwater, 1 skin; Bouse Junction, 4 skins; Bear Creek, 10 skins; Edith, 3 skins; Corbin Cave, 7 skins; Marehew Cave, 2 skins; Graver Creek, 1 skin. *Texas*: Bracken Cave, 1 skin; San Antonio, 3 skins; Chisos Mountains, 5 skins; The Basin, 1 skin; Burro Mesa, 1 skin; Encinal, 1 skin; Kent, 1 skin; College Station, 1 skin; San Carlos, 1 skin; Chinati Peak, 1 skin; Paisano, 1 skin; Kerrville, 5 skins; Grapevine, 2 skins; Hunt, 2 skins; Bandera, 2 skins; Ney Cave, 24 skins, 1,460 live; Frio Cave, 188 skins, 2,628 live. *Mexico*: Distrito Federal: Tlahuac, 1 skin. Jalisco: Autlan, 2 skins; Las Canoas, 2 skins. Durango: Río Sestin, 1 skin. Michoacán: Patzcuaro, 2 skins; La Palma, 2 skins; Tancitaro, 1 skin. Baja California: La Grulla, 1 skin. Nuevo Leon: Río Ramos, 1 skin; Monterrey, 1 skin. Guerrero: Chilpancingo, 1 skin. Sonora: Pilares, 1 skin.

Myotis velifer incautus (J. A. Allen)

Specimens used in this analysis came from a little more than one-half the geographical area inhabited by this subspecies. No specimens were obtained from Colorado and Utah.

Molt.—Large series of Frio Cave specimens, collected in July and August, demonstrate the occurrence of molt in both sexes. Seventy adults, taken July 6, 1948, include 69 females in faded pelage and a single molting male. Among 372 adults taken on July 17, 321 were females in faded coat, 27 were molting females, 17 were molting males, and 7 were males in fresh pelage. Thirteen

adults were collected August 16–21, 1944; 3 were males in fresh coats, 1 female was in faded pelage, and 9 females were in the final stages of molt. It appears that males molt as early as July 6 and females as early as July 17. The period of time during which molting specimens were taken covered approximately one month for each sex. This schedule is in agreement with the taking of specimens from other localities. In July, the earliest month in which young were collected, they were found to have a full coat. As the hair grows longer, portions of the coat assume greater luster and an ill-defined pseudomolt pattern is evident, which may represent a difference in growth rate in hairs of certain areas. Lack of pigmented follicles and early hair growth stages indicate that this is not a true molt. The adult molt pattern is illustrated in Fig. 2.

General distribution of pigment in hair.—Pigment in dorsal and midventral hairs is usually confined to two zones: (1) The basal one-half to three-fourths is blackish-brown to plumbeous-black; (2) the terminal one-fourth to one-half is a lighter color. A third color zone, usually buffy brown, frequently occurs between the basal and terminal zones of dorsal hairs in both lighter and darker pelages but the effect produced by it is negligible. The color of the terminal zone is dominant in effect, and will be used in assigning color values.

Fresh coat.—The fresh adult coat has considerable variation. Dorsally it varies from avellaneous through drab, buffy brown and olive brown to sepia. The ventral surface varies from pinkish buff to light buff.

Faded coat.—Fading is first evident in spring. Dorsally the faded adult coat usually varies from tawny-olive to a color between tawny-olive and Sayal brown. The venter is a pinkish buff to warm buff. Faded pelage of Frio Cave specimens varies dorsally from a color between Sayal brown and tawny-olive

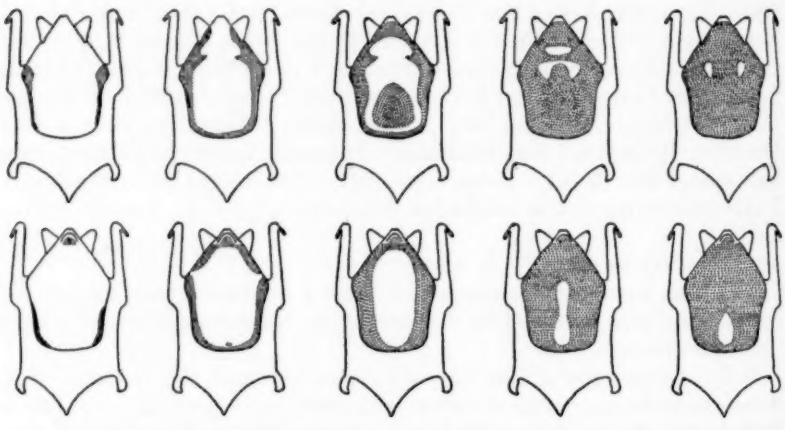

FIG. 2.—Molt pattern of *Myotis velifer incautus*. Upper row: dorsal view. Bottom row: ventral view. New hairs appear in the stippled areas. Molt progresses from left to right. The dorsum is almost completed before the venter begins to molt.

to Sayal brown, and ventrally from cinnamon buff to ochraceous buff.

Coat of young.—The pelage of the young of the year is dull. Dorsally it varies from sepia through olive-brown to tawny-olive. The venter is a pinkish-buff to warm buff.

Specimens examined.—From the following localities, 759 specimens were examined. *Kansas*: Havard Cave, 16 skins; Sun City, 2 skins. *New Mexico*: McKittrick Cave, 5 skins; Carlsbad, 2 skins. *Oklahoma*: Graver Creek, 1 skin; Waynoke, 4 skins; Alabaster Cave, 29 skins; May, 2 skins; Corn, 1 skin. *Texas*: Encinal, 13 skins; Big Bend, 4 skins; Marfa, 1 skin; Madera Canyon, Jeff Davis County, 1 skin; San Antonio, 3 skins; Shumla, 18 skins; Buda, 1 skin; Kerrville, 4 skins; Mouth of Pecos River, 1 skin; Frio Cave, 227 skins, 418 live.

DISCUSSION

It appears that several important points have been demonstrated: (1) Both species studied undergo a single molt each year; (2) males molt earlier than females; (3) the fresh pelage eventually fades to a remarkable extent; (4) the degree of fading varies in different geographical areas.

Field data and experimental evidence indicate that the excessively light color of faded Ney Cave and Frio Cave specimens is produced in the caves by a bleaching effect of ammonia gas and water vapor. This problem is to be the subject of a subsequent paper.

The phenomena described herein might be extrapolated to suggest that taxonomic distinction, based on color alone, should be conferred only after the candidate has demonstrated distinction in fresh pelage. It is suggested, however, that the following potential problems be considered when employing color as a taxonomic criterion: (1) Number of molts per year and time of their occurrence, considering possible age, sex, and geographical differences; (2) pattern of molt to avoid misinterpretation of color pattern; (3) color variation in fresh pelage, considering possible age, sex, and geographical differences; (4) potential fading of color of this same coat in different areas; (5) residence of subject in different geographical areas at different seasons with respective seasonal pelage predominating in each area; (6) degrees of geographically distinct fading in a species which may hibernate in a part of its geographical range and elsewhere remain active throughout the year; (7) degree of fading in a population, in which part may migrate, while the other members remain sedentary but active; (8) possible differences in color fading resulting from segregation of sexes and redistribution of each sex to different areas.

ACKNOWLEDGMENTS

The following institutions, organizations, and private collectors generously made available, on loan, bat specimens from their collections: the University of Colorado Museum; the Dallas Museum of Natural History; the University of Oklahoma; the University of Washington; Dixie Junior College at St. George, Utah; Walla Walla College; the Chicago Natural History Museum; the Coolidge, Arizona, office of the National Park Service; the University of Arizona; the Texas Cooperative Wildlife Museum; the Carnegie Museum; the Allan Hancock Foundation of the University of Southern California; the Los Angeles Museum; the University of

Michigan Museum of Zoology; the American Museum of Natural History; the University of Florida; the Oklahoma Agricultural and Mechanical College Museum of Zoology; the University of Kansas Museum of Natural History; the Santa Barbara Museum of Natural History; San Francisco State College; the University of New Mexico; the Museum of Comparative Zoology; the California Academy of Sciences; and the Collection of Alex Walker.

Communicable Disease Center, U.S. Public Health Service, Newton, Georgia. Received April 28, 1956.

THE USE OF FOOD AS A BUFFER IN A PREDATOR-PREY SYSTEM

By David E. Davis

The purpose of this report is to explore the role of a buffer in the problems of predation. The particular system used was that of cat-rat because the numbers of predators and of prey can be counted and manipulated and a buffer can be easily provided. While of course this system lacks the complexities of a completely wild predator-prey relationship, it is believed that much can be learned by simplifying the problem and approaching it experimentally.

The theory of a predator-prey system has been elaborated mathematically by many writers for a generation and is now a part of general ecological knowledge. In brief, the system involves several species, some of which eat the others. As the prey increase the predators follow and in some cases consume enough prey to cause a decline of prey. Then the predators decline till they no longer can hold the prey in check and the prey again increase. The critical point in reference to buffers is the extent of decline of prey. It is possible for the prey to become so scarce that the predators may starve or leave. Then of course the prey can increase very rapidly until other predators arrive. But if a buffer is present the predators can turn to it when the prey become scarce and thus the predators remain and are ready when the prey begins to increase. The buffer thus may keep the predators on hand to check the increase of prey and thereby the predators may hold down the prey population.

Among predator-prey systems involving two vertebrates there exist few cases in which the predator really limits the prey population, although such cases are common among invertebrates, especially insects. Apparently the adjustment of changes in populations is not suitable, among vertebrates, to permit predators to maintain a number (at the time of low prey populations) that can be ready for the increase of prey.

To test this idea it seemed desirable to maintain a high population of cats by a buffer and determine its effects on the rat population.

Methods.—These experiments were conducted on a farm northwest of Baltimore that has been used since 1946 for various studies (Davis, 1948; Davis *et al.*, 1948; Davis and Hall, 1948; Davis, 1949; Davis and Hall, 1951). Since 1952 no experiments have been conducted but a simple estimate of the population has been made by a routine trapping procedure. The farm has had one male cat in the milking barn for the past few years.

The cat population was increased by adding cats. The cats were said by the seller to have come from farms. This claim was checked by keeping the cats for a few days and examining their feces. Only cats that had eaten squirrels, rats, or field mice were used. At first the cats were simply released on the farm but three promptly disappeared. Subsequently the cats were liberated gradually. They were kept and fed in a cage for several days before opening the door. Food was available in the cage for several more days. Under this procedure the cats remained on the farm. The cats were placed and fed in two or three different buildings at various times.

The basic procedure was to alternate feeding and non-feeding periods of two months' duration and to examine the changes in the rat population and the proportion of cats' feces that contained rat hairs. Table 1 gives the dates of trapping rats and feeding cats and the cat and rat population. The number of cats is actually the number present at the end of the trapping period. The low number in February does not adequately represent the average situation during this time. Two cats were killed by dogs in early January at the time of trapping and were replaced as soon as possible in February.

TABLE 1.—*History of cats and rats*

DATES OF TRAPPING	CATS	FOOD*	RATS PER 100 TRAP NIGHTS	SCHNABEL ESTIMATE
Oct. 18–22	4	no	88	264
Nov. 15–19	4	yes	23	132
Dec. 13–17	4	yes	38	128
Jan. 11–15	2	no	36	63
Feb. 7–11	4	no	33	55
Mar. 6–10	4	yes	48	63
Apr. 3–7	5	yes	44	179
May 1–6	4	no	52	66
May 29–June 2	4	no	52	

* Provision of cat food during preceding month.

The number of rats was estimated simply by calculating the rats caught per trap night. The rats were marked and released. Various versions of the recapture method were used but with the small numbers of animals the variability due to sampling was very great. For example, the Schnabel estimate (Table 1) gives a great increase in April which is apparently due to sampling error. Another disadvantage of the recapture methods is that they provide no estimate for May–June which is the most important period.

During this last period, in order to get as large a sample as possible, steel traps were used in addition to the box. Previous work on the farm had not indicated a difference in age or sex composition of the samples taken by the two types of traps. Thus from October 9–12, 1951, box traps caught 69 rats of which 23.2 per cent were immature and 44.9 per cent were males. These rats were released

and then from October 23–25, steel traps caught 101 rats of which 23.8 per cent were immature and 44.6 were males. On this basis it was considered permissible to compare the captures by steel traps with the captures by box traps. The actual results agreed with this prediction and showed no apparent bias.

The species mentioned in this paper are: *Rattus norvegicus, Mus musculus, Microtus pennsylvanicus, Felis domesticus,* and *Columba livia* and *Passer domesticus.*

Results.—The rat population on the farm since in 1953 is given in Fig. 1. In general, the population increased in the spring and decreased in the winter. In October, 1955, conicident with the addition of the three cats, the rat population declined about two months earlier than had occurred in previous years. Some confirmation of the decline (Table 1) may be obtained by another

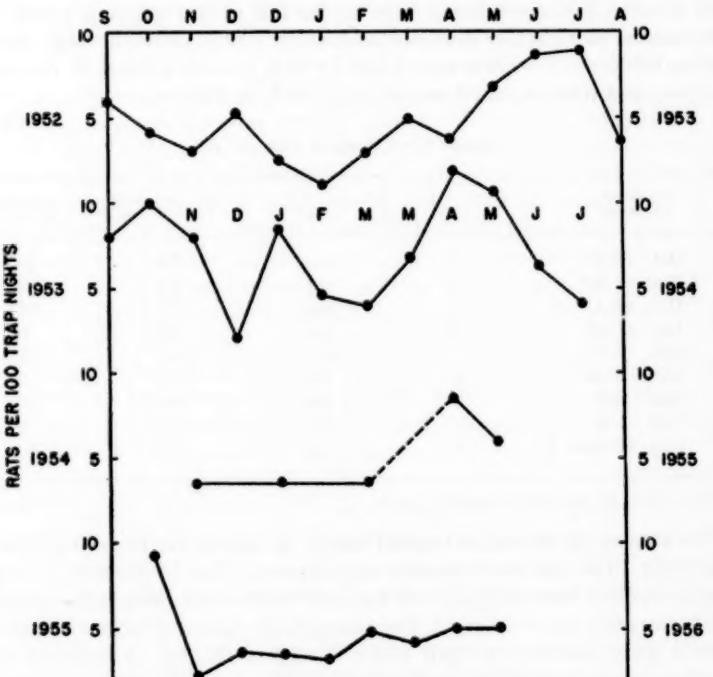

FIG. 1.—The captures of rats from 1953–56. Before 1955–56 the population decreased in the winter and increased in the spring. In 1955–56 the population decreased in October and increased trivially in the spring. (Because the year was divided into thirteen 4-week periods, there are two records for December, 1952, two for March, 1954, and two for May, 1956.)

TABLE 2.—*Age and lactation status of farm rats*

YEARS	FALL			WINTER			SPRING			SUMMER		
	♂	♀	Lact.	♂	♀	Lact.	♂	♀	Lact.	♂	♀	Lact.
	Percentage of male or female rats that were mature or lactating											
1952–53	72.2	90.5	0.	83.4	80.0	50.0	75.0	86.7	23.1	10.0	10.0	12.5
1953–54	50.0	69.2	11.2	100.	91.6	0.	64.1	77.3	29.4	33.3	33.3	0.
1954–55	50.0	75.0	33.3	0.	75.0	0.	88.9	90.0	55.6	83.5	0.	
1955–56	60.0	80.7	10.8	100.	94.5	0.	75.0	92.4	33.3			
	Total number examined											
1952–53	35	21	19	12	5	4	20	15	13	10	16	16
1953–54	20	13	9	7	12	11	25	22	17	3	3	1
1954–55	2	4	3	3	4	3	9	10	9	6	2	
1955–56	40	47	38	16	18	17	24	26	24			

census method which determines, from an examination of recaptures, the number *known* to be alive. A rat was known to be alive in a month if subsequent recaptures or back-calculation from the weight when first caught showed that it must have been present even though not caught. By this means the numbers are: October, 64 rats; November, 45; December, 48; January, 38. These results support the conclusion that the decline occurred between October and November.

In the spring of 1956 there was only a trivial increase (Table 1) in rats in contrast to the previous years.

The age composition is given in Table 2. Male rats that have testes descended into the scrotum or females that have the vaginal orifice perforated are considered mature. (The seasons were based on climate and thus did not include the same dates each year. However, they were essentially: September to December; January to early March; late March to June; July to September.) It is apparent that when the years are compared by seasons no striking change in the proportion of mature rats occurred in 1955–56. Essentially the same can be said for the proportion lactating.

These seasonal figures, however, should be examined in detail to indicate the extent of production of young rats in the spring. Examination of the figures from February to May–June in the various years shows that immature and lactating individuals were present in all these months in each year from 1952 to 1955. But in 1956 immature and lactating rats appeared only in May. Table 3 shows this contrast. It is clear that production of young had been greatly decreased in these early months. Although the season was generally late for birds and plants there is no reason to believe that this affects rats. Evidence from rats caught in February in Baltimore showed 6 lactating and 8 pregnant out of 26 mature females, indicating that the breeding season began normally. (None were trapped in the city after February.) An apparent reason

that the young rats reached trappable age in May–June is that the cats turned to squabs which are produced in this area in May since the peak of pigeon laying is in April.

The consumption of rats by cats could not be measured quantitatively since the number of rats caught by cats could not be determined. The examination of feces for rat hairs was hindered by the difficulty of finding cat feces. The reason was apparently that the cats had ample defecation spots in the shavings used for the horse stalls and the feces were removed regularly when the stalls were cleaned. Sand boxes were not used at first and a thorough search from October to January did not uncover any cat feces.

However, in January and February a total of 34 recent scats were found, of which 78 per cent contained rat hair, 38 per cent mouse hair, 15 per cent pigeon feathers, and some meadow voles or sparrows. These scats represent a time when the cat food buffer was not available.

In February it was realized that the only way to get scats from each cat was to pen up the cats once a week and thus get the feces. From February 9 to April 4 (feeding period) a total of 30 scats was collected of which 60 per cent contained rat hair, 3 per cent mouse hair, and meadow voles and pigeons were also represented. Evidence of cat food was present in 80 per cent of the scats. These numerical differences from the non-feeding to the feeding periods are not statistically significant and thus the data do not demonstrate a decline in consumption of rats and mice.

After feeding stopped, 29 scats, collected from April 13 to June 8, showed 31 per cent with rat hair, 28 per cent with mouse hair, 24 per cent with feathers. During this time one or more cats started using the sand box in the barn. This particular building lacked rats (none were captured and no signs were seen). In May, 36 feces were examined. The results were that 56 per cent had rat hair, 17 per cent had plant fibers, 25 per cent had feathers.

The question of the size of the rats caught by the cats is important. Laboratory

TABLE 3.—*Age composition and lactation from February to June, 1956*

	FEB.	MARCH	APRIL	MAY–JUNE
Age composition:				
1952–55 rats	17	25	31	42
% mature	88.2	84.0	77.4	88.1
1956 rats	11	12	11	39
% mature	91.1	100.	100.	79.5
Lactation:				
1952–55 females	5	11	13	18
% lactating	20.0	18.2	30.6	33.3
1956 females	5	7	6	20
% lactating	0.	0.	0.	40.0

tests of rat-killing ability of cats failed completely. Cats known to have killed rats on the farm ignored rats under a variety of situations away from the farm. Cats certainly ate large (300 gm.) rats for the skins were seen where the cats ate on several occasions. However, some large rats lived for several months at least. One rat was marked in October and caught in May.

Discussion.—The function of a buffer is to maintain the predator during a period of scarcity (low population) of the prey. In this case the provision of the buffer (cat food) was scheduled to determine whether the predators would eat the prey even though the buffer was present. There was no doubt that the cats would eat cat food when rats were scarce. The real question was whether the cats would eat rats when they began to increase in the spring. Actually the test was designed to give the maximum advantage to the rats but the cats continued to eat rats and the expected spring increase in rats did not occur.

Other buffers than cat food were present, for the cats consumed large numbers of pigeons, especially during the birds' breeding season. The cat feces do not adequately show the numbers of pigeons consumed for, in an area of the farm where there was a pile of feathers a foot deep, the cat feces contained feathers only once. However, the increase of feathers in the feces is a reflection of the change in diet of the cats.

It seems desirable to comment on the characteristics of a good buffer both from the viewpoint of predation theory and the practical aspects of rat control. A buffer should be readily available at a time of scarcity of the main prey so that the predator population can be kept high. The buffer of course should be palatable, and have an adequate reproductive rate. The essence of biological control (i.e., cats reduce rats) is to maintain a high predator population when the prey is scarce.

Some practical comments on the use of cat food as a buffer are pertinent. The object is to maintain a high population of cats so that their incidental captures of rats will control the rat population. The basic procedure in rat control is to alter the farm environment so that rats will have little food and few places to hide. When introduced, the cats should be accustomed to the food and farm. They should be kept in cages in the barns or buildings and fed cat food. After a few days the doors can be opened and the cats gradually released. The food will serve to hold the cats on the farm. To maintain a high cat population the food should be placed in several spots rather than in just one place.

Summary.—To explore the role of a buffer in a predator-prey system a test of the use of cat food was organized. Cats on a farm were increased in number and given cat food for two 2-month periods alternated with non-feeding periods. The rat population was compared with the data from three previous years. The rat population declined in the fall (cats being fed) earlier than in previous years. In the spring the rat population did not increase (cats being fed) in March and April as usual. In May the rat population increased when the cats turned to squabs for food. Examination of cat feces showed that rat hairs were

present in about the same number in the periods when the cats were fed as when they were not fed.

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Johns Hopkins School of Hygiene and Public Health, Baltimore 5, Maryland. Received August 7, 1956.

THE DESERT WOODRAT: A LABORATORY COLONY

BY HAROLD J. EGOSCUE

The success of laboratory or simulated epizoological studies and related research involving native mammals may be dependent upon an assured supply of the species being studied. If the research is purely bacteriological in nature, then it is often required that the animals be reared under standard conditions and have a known pedigree—preferably at least second or third generation laboratory-reared stock.

After two years of study (1953–55), a breeding colony of desert woodrats, *Neotoma lepida lepida* Thomas, was established in the Faunal Colony of Ecological Research, University of Utah, at Dugway, Utah. Testing the practicability of this species as a laboratory animal was part of a program designed to examine the mass rearing possibilities in the laboratory of several rodents native to the western Utah desert. Bushy-tailed woodrats, *Neotoma cinerea acraia* (Elliot), also were reared but on a much smaller scale.

This paper reports methods used to produce more than 200 laboratory-bred desert woodrats in close confinement. Other data, such as gestation period, litter size, age of puberty, longevity as breeders, sex ratio and yearly reproductive potential are given. Since a knowledge of the habits of an animal in nature is often helpful in keeping and rearing the species in captivity, certain pertinent field observations on this woodrat are also included.

Dependable laboratory and field assistance from B. N. Day and Eddyjo Ekker is gratefully acknowledged. Other Ecological Research personnel who generously contributed advice and assistance include: A. M. Woodbury, Director; D. M. Allred, Chief Ectoparasitologist; E. D. Vest, Chief Ecologist; E. A.

Shippee, John Smith and D. D. Parker. Acknowledgment is also extended to Robert Holdenried for reading the manuscript.

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METHODS AND PROCEDURES

Parent stocks for the colony were obtained from the south end of the Cedar Mountains and from Granite Mountain in south-central Tooele County. Most of the animals were trapped in 18-inch Havahart traps baited with grain and set in the immediate vicinity of woodrat houses or cliffs and ledges that showed signs of woodrat occupancy. Most field observations were made while collecting animals for breeding stock.

Cages were designed which took into consideration the well-known solitary habits of the woodrats, but at the same time permitted pairs to associate if they so desired. Figure 1 illustrates the cage currently being used. Since laboratory space was at a premium, these specifications represent about the minimum, but not necessarily the optimum, space requirements for the species. About one inch of fine sand on the floor of the cage was provided for dust bathing and to absorb liquids. Cotton was provided for nesting material. No attempt was made to duplicate natural environmental conditions. An average yearly temperature of 70° F. was maintained in the laboratory, but no record was kept of the relative humidity.

After trial confinements, wild-trapped rats that appeared to have become most accustomed to cage conditions and laboratory diets were selected for breeding stock. When pairing was attempted, the animals were introduced together into a cage unfamiliar to both prospective mates. This eliminated most of the fighting which otherwise occurred when territorial ownership had been previously established by one of the pair. If the pair did not adjust to each other after a week or ten days, they were separated and either introduced to other cage mates or discarded as breeding stock.

The same cage (without modification) was used to house the young animals after they were weaned. To prevent fatalities due to fighting, each individual was kept in a separate cage.

A cone (7 ½ in. long and 2 ¾ in. in diameter at the base) made from ¼-in.-mesh hardware cloth, facilitated handling the wild-trapped adults. The rats usually entered the cone when it was held immediately over them (if they were sitting up) or in front of them and they were startled from behind; the animal was then prevented from backing out of the cone by the other hand. Most of the laboratory-reared animals could be picked up by the tails, if care was taken to grasp the tail near its base. Otherwise, the least amount of struggling often caused the tail sheath to slip.

Some difficulty was experienced in detaching the young for examination without damaging the nipples, until it was discovered that detachment could

be accomplished by placing the thumb over the nose of the young, thus briefly preventing it from breathing.

Once a week, breeding pairs were fed about 12 oz. of a mixture composed by volume of 60 per cent rolled oats or barley, 20 per cent alfalfa hay leaves, 10 per cent sunflower seeds, and 10 per cent pigeon mix (containing wheat, corn, kaffir, milo, millet, field peas and vetch). Lesser amounts were fed to animals housed individually, depending on size and age. The dry diet was supplemented twice a week by a medium-sized raw carrot and a slice of orange per animal. Cabbage leaves were substituted when carrots were not available. About twice a month a small branch of freshly cut juniper was given. Most rats readily ate the leaves and berries and gnawed the heavier limbs, which may have helped prevent abnormal tooth development. Some food in excess of needs was provided to help satisfy food-storage instincts. Water was available at all times (Fig. 1).

When rats died in the laboratory from other than accidental causes, a post-mortem examination was conducted and the cause of death determined when possible.

RESULTS AND DISCUSSION

Distribution and habitat.—The desert woodrat is not continuously distributed throughout its range. In western Utah, it was found in suitable habitat on all the lower desert ranges such as Cedar, Dugway and Fish Springs mountains, and up to about 7,000 ft. in the Stansbury and Deep Creek mountains; only an occasional individual was collected in the intervening flats and valleys. These were usually young animals that presumably were wandering about seeking home sites. Some were captured several miles from areas that normally supported woodrats. Movements of this kind in the past probably account for the spread of these animals into all of the many more or less isolated ranges of the Bonneville Basin and elsewhere. They may also be responsible for the gene flow necessary to maintain *Neotoma l. lepida* as a fairly stable subspecies over a large area.

In Tooele County, woodrats were especially numerous in the lower foothills near the south end of the Cedar Mountains. Here, their conspicuous houses were found at the bases of junipers or built where a lower branch of this tree made contact with the soil. A number of houses were located in forks of junipers, often several feet above the ground. The houses were constructed mainly of dry branches and twigs of juniper, but included the usual accumulations of bones, owl pellets, horse and coyote feces, bits of cacti, and sundry other objects. Where the animals lived in crevices of ledges or cliffs or under boulders, these accumulations were much less in evidence, often amounting to only a few sticks and small stones. One individual was found living in a slightly modified raptor's nest, 20 ft. above ground in a juniper tree. The nest had been occupied the previous year by a pair of red-tailed hawks. There was also some indication that both raptors and woodrats sometimes "borrowed" from materials assembled

by the other. Partially dismantled hawk nests were observed in trees that had occupied, well-made rat houses at their bases; the reverse situation was about equally common. Each house contained from one to three nests, usually made of finely shredded juniper bark.

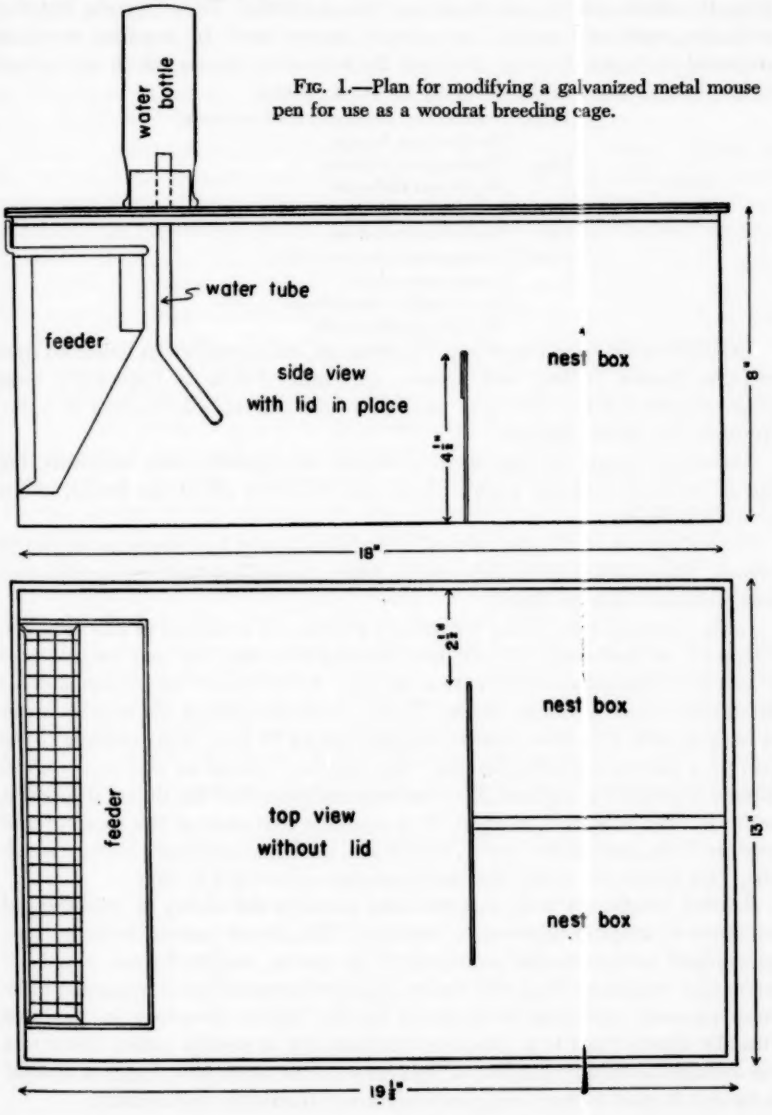

FIG. 1.—Plan for modifying a galvanized metal mouse pen for use as a woodrat breeding cage.

Animal associations.—Both nests and houses serve as home and refuge for numerous parasites and invertebrate commensals. The invertebrate fauna collected from nests and houses from Tooele and Juab Counties in western Utah was studied extensively by Allred and Beck (1953), Allred and Roscoe (1956), Howell (1956*a* and *b*), and Beck and Allred (1955). These reports, together with the results of a general ectoparasite survey made by brushing woodrats collected in Tooele County, included the following species which are judged to be of importance in the economy of the woodrat:

Ticks: *Dermacentor parumapertus* (immature)
Ornithodoros hermsi
Mites: *Hirstionyssus bisetotus*
Brevisterna utahensis
Trombicula sp.
Lice: *Neohaematopinus* sp.
Fleas: *Orchopeas sexdentatus agilis*
Stenistomera alpina
Anomiopsyllus amphibolus
Megarthroglossus smiti

In addition, the cone-nosed bug, *Triatoma* sp., occasionally was collected from woodrat houses (Allred and Roscoe, unpublished data). Apparently these bugs are rare this far north and their effect on woodrat populations of northwestern Utah is not known.

Larvae of cuterebrid flies were collected infrequently from woodrats, but not in sufficient number from a single individual to affect the health of the animal obviously.

Several species of vertebrates used abandoned houses for escape cover and/or homes. These included the deer mouse, piñon mouse, antelope ground squirrel, and brown-shouldered lizard.

Little is known concerning the natural enemies of woodrats in this area but, judging from their comparatively low reproductive rate, they may be subjected to less predation pressure than other rodents. R. D. Porter (unpublished data) listed four desert woodrats among 57 prey items brought to the nest by a pair of horned owls, and three desert woodrats among 73 prey items brought to the nest by a pair of red-tailed hawks. The fact that diurnal as well as nocturnal raptors were able to capture these animals indicates that the desert woodrat is active by day as well as at night. It is assumed that most of the carnivores of western Utah, such as the coyote, bobcat and kit fox, occasionally capture woodrats. One house was found that had been torn apart by a badger.

Rearing results.—A wide variation was noted in the ability of wild-trapped woodrats to adapt themselves to captivity. The desert species, with its more generalized environmental requirements in nature, adjusted more readily to laboratory conditions than did the bushy-tailed species which appeared to be more narrowly restricted ecologically to the higher elevations in this area (usually above 6,000 ft.). Because the humidity is usually rather low under the average laboratory conditions, success with the more xeric forms is thought to be due in part to their comparatively lower humidity requirements.

Some extremely nervous wild-trapped woodrats appeared to have died of shock induced by confinement. Many of these animals did not build nests and ate little or none of the food offered. They usually survived less than two weeks. Poorly adjusted rats seldom breed in captivity. Docility and the ability to adapt to confinement may, in some cases, be passed on from adults to their offspring. Such a pattern became evident in the colony, especially among the progeny of one exceptionally tame old male. This inherent behavior may be parallel to that observed by Leopold (1944) in his study of heritable wildness and domesticity in turkeys.

After the pairs selected for breeding stock became settled, wide variation in the territorial division between individuals of the several pairs was noted. Some pairs shared one of the nest boxes except when the female was nursing young. In others, one individual appropriated both nests and used one for food storage. A variety of other nesting arrangements existed, including one where the nesting spaces were seldom used except when the animals wanted to escape capture. It is entirely possible that the cage being used is not of optimum size, especially for wild-trapped adults. This may account also for the difficulty some laboratory-reared pairs had in adjusting to the cage. Similar difficulties were seldom observed when larger cages were used during earlier phases of the study. However, with the present cages these problems have decreased as the wild-trapped breeding stock was replaced by laboratory-reared animals.

As many as 14 young (average 9) were produced by a pair in one year; the average number of litters per female was approximately four. An average of 2.3 young (range 1 to 5) were born following a gestation period of 30 to 36 days. The data in Table 1 show that nearly half of the litters were litters of two. The average weight at birth was 10.4 grams. At this time the young of large litters weighed slightly less than did the young of small litters.

In comparison with some other rodents, young woodrats are born in a rather advanced state of development. The dorsum is already heavily pigmented, and the tips of the hairs can be seen. Measurements showing the early growth and development of a litter of two are summarized in Table 2. The eyes open in 11 to 13 days in contrast to deer mice that usually require about 14 days. Prior to weaning the young rats grow rapidly although there may be considerable varia-

TABLE 1.—*Woodrat litter sizes, based on 100 litters*

SIZE OF LITTER	NO. OF LITTERS	% OF TOTAL LITTERS	NO. OF YOUNG	% OF TOTAL YOUNG
1	16	16	16	7.0
2	49	49	98	42.3
3	27	27	81	35.3
4	6	6	24	11.0
5	2	2	10	4.4
Totals	100	100	229	100.0

bility in weight among individuals of the same age. Young *Neotoma* of all species spend much of the early nursing period attached to the nipples with the aid of specially modified incisors. Hamilton's (1953) detailed description of the incisor development in young Florida woodrats is almost identical with that observed in desert woodrats. Observations of the desert species also corroborate Hamilton's suggestion that the gradual evolution from the modified incisor to the definitive incisor takes place through wear. The study also clearly indicates that by the time the young desert woodrats were 12 days old, the incisors were no longer as effective in maintaining a secure hold on the nipples because of the change to a more definitive form. Nursing continued for approximately four weeks but the young began eating some solid food about the end of the third week. When the females were nursing a small litter (1–2 young) the anterior pair of teats usually dried up.

TABLE 2.—*Early growth and development of two woodrats born Oct. 28, 1954, as shown by weights and measurements on given dates*

DATE	WEIGHT, gm.			LENGTH, mm.								REMARKS
				Tail			Hind Foot			Ear		
	♀	♂	Av.	♀	♂	Av.	♀	♂	Av.	♀	♂	
Oct. 29	—	—	12.25	27	25	26	14	13	13.5	6	6	Ear folded
Nov. 2	18.3	18.0	18.15	35	32	33.5	18	18	18	10	10	Ear still closed, upper and lower incisors still modified
Nov. 3	19.3	19.3	19.3	37	35	36	19	19	19	10	10	Same as above
Nov. 5	21.1	20.8	20.9	37	37	37	21	21	21	10	10	Same as above
Nov. 7	23.7	23.3	23.5	39	38	38.5	22	21	21.5	12	12	Ears and eyes opened
Nov. 8	24.8	—	—	41	—	—	22	—	—	12		Male could not be detached from nipple

In some males, growth may continue for almost two years, although several of the males used for breeding stock reached their maximum size in 6 to 7 months. The average weight of laboratory-reared males 6 months to 3 years old was 209 grams, while the average weight of non-pregnant, non-lactating, laboratory-bred adult females of about the same age range was 139.9 grams. By way of comparison, the average weights of 16 wild-trapped adult males and 8 wild-trapped adult females were 177.1 and 138.4 grams, respectively. Captive males tend to become fat while captive females maintain weights more nearly like those of wild individuals. The physiological drain from repeated pregnancies and lactations probably prevented captive females from becoming overweight. The data clearly show adult males are much larger than females.

Females became sexually mature in two or three months. There were several

records of young born to animals 90 to 113 days of age, indicating that oestrus occurred when some of the females were only two months old. The earliest age when males reached puberty was not established. During oestrus the vulva was swollen and bright pink in color. At this time, the male followed the female about the cage, periodically licking and smelling her genital region and occasionally making a peculiar buzzing or humming sound. Coitus was not observed but was believed to take place usually at night. Under laboratory conditions females were polyoestrous, young being produced every month of the year. A well-defined breeding season was not evidenced in the breeding colony although a few females failed to breed during December and January. Oestrous immediately followed parturition in some females but was delayed in others until after weaning. The maximum longevity of breeders is not known, but three-year-old pairs were still producing litters regularly when they died from undetermined causes. A 1,065-day-old male was still sexually active and continued to sire litters regularly. The sex ratio, based on over 200 animals, was approximately 1:1. The lifetime reproduction record of a wild-trapped female during captivity is summarized in Table 3. The somewhat regular interval of about 60 days between litters produced by this female was the only case in the colony of such constant periodicity.

TABLE 3.—*Lifetime reproduction record during captivity of a pair of woodrats paired in December 1952; both animals were wild-trapped*

LITTER NUMBER	LITTER SIZE	DATE BORN	SEX	
			♂	♀
1	3	March 19, 1953	2	1
2	2	May 3, 1953	1	1
3	2	June 28, 1953	1	1
4	2	Aug. 21, 1953	2	
5	2	Oct. 21, 1953	2	
6	2	Feb. 25, 1954		2
7	3	April 10, 1954	1	2
8	3	June 11, 1954	1	2
9	2	Aug. 7 or 8, 1954	1	1
10	1	Dec. 2, 1954		1
12	3	Jan. 7, 1955	1	2
13	3	March 8, 1955	1	1
14	3	May 7, 1955		
Totals	31		13*	14*

* Does not include last litter, of which parents and three young were found dead on May 31.

The maternal instinct appears to be strongly developed in the desert woodrat. Females were extremely solicitous of their young, especially during the first two weeks. During this period, females readily accepted the young of other

females that died or were unable to care for their litters because of a failing milk supply. Complete success was achieved in attempts to foster young with other females. When possible, the young were given to a female having a litter of similar age. Two females accepted day-old cottontails into their nests; they lived for about 36 hours during which they were groomed and warmed by the rats, but apparently did not nurse.

Under laboratory conditions, mortality resulted from several causes. Several animals were accidentally crushed between the lid and the rim of the cage. One female died during parturition; examination showed the embryo to be oversize. A tightly compacted accumulation of fur in the lower stomach and duodenum, probably swallowed in small amounts as the animal groomed itself, resulted in the death of at least one individual. A pair of adults and their month-old litter all died within a few hours of one another from what was thought to be murine typhoid. A bloody anal discharge and inflamed intestinal tract accompanied this infection. Parasitic mites may become a serious pest if cages are allowed to go uncleaned for long periods. One such case would probably have resulted in the eventual death of the woodrats had the condition been permitted to continue. By far the greatest cause of mortality was fighting. Most of the deaths resulted from bites around the genital region. Many males in particular died from multiple bites on the testes. Some females were so constantly harassed by males that they probably would have starved to death if they had not been separated.

CONCLUSIONS

For obvious reasons, many mammals are unsuitable for general laboratory purposes. However, a species may exhibit certain unique qualities such as a high susceptibility to a specific disease, host specificity for a particular parasite, or any of numerous qualifications which make it worthwhile to establish a laboratory colony of the species. Although the desert woodrat is of suitable size for many types of research and is easily reared and handled, the experience here suggests that large-scale production of these animals is not likely to be attempted because of their relatively low reproductive potential and unsociable tendencies. A breeding colony of 100 pairs would have to be maintained to produce 900 young animals per year; some of these would have to be used for replacement of breeding stock in the colony. A large colony would require much laboratory space and many cages to house the animals singly as they are weaned.

It is believed that the desert woodrat qualifies as a special-purpose laboratory animal, offering good possibilities as a species which can be reared and used during special investigations of desert areas.

SUMMARY

Rearing methods and life history data are given for the desert woodrat, *Neotoma lepida lepida* Thomas. The females are polyoestrous, giving birth to an average of nine young per year. One to five young (average 2.3) are born

following a gestation period of 30 to 36 days. Data on growth and development of young are given. Some females become sexually mature when only 60 days old. Both wild-trapped and laboratory-reared males are markedly larger than females. Selection of the more docile animals for breeding stock over a two-year period resulted in animals which seemingly are better adapted to life in close confinement than the original wild-trapped stock. Longevity as breeders was at least three years. Based on present knowledge, it is believed that the desert woodrat lacks the necessary qualifications for a general laboratory animal, but qualifies as a species which can be successfully reared for special-purpose studies.

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REINGESTION IN THE BLACK-TAILED JACK RABBIT

By R. R. Lechleitner

It has long been known that the domestic rabbit produces both hard and soft fecal pellets (Morot, 1882). The hard pellets are the normal waste product of the digestive tract and are the feces one finds in the field. The soft pellets are a special product of the caecum, and the rabbit takes them directly from its anus and swallows them whole. Morot's observations went virtually unnoticed until they were confirmed by Madsen (1939), but since that time many workers have become interested in the phenomenon and it has been variously termed "pseudo-rumination," "refection," "coprophagy," and "reingestion." The latter term is perhaps most appropriate (Watson, 1954) and is used throughout the present paper.

Most of the investigations have been concerned with reingestion in domestic varieties of *Oryctolagus cuniculus*, but Southern (1940) showed that reinges-

tion was a normal part of the biology of the species in the wild. Watson (1954) and Meyer (1955) confirmed and amplified the observations of Southern on wild populations of the same species in New Zealand and Australia, respectively. As early as 1895 it was suggested that the same phenomenon occurred in the European hare (*Lepus europaeus*) and Watson and Taylor (1955) verified this in the introduced hares of New Zealand. The latter authors suggest that reingestion may be a normal feature of lagomorph biology, and emphasize the scarcity of data on reingestion in the many North American species. Hamilton (1955) notes the presence of fecal pellets in the stomach of a swamp rabbit (*Sylvilagus palustris*) from Florida, and Kirkpatrick (1956) describes the act of swallowing feces by a cottontail rabbit (*Sylvilagus floridanus*). Except for these two reports, no other published information is available on reingestion in any of the American lagomorphs.

During a study of the ecology of the black-tailed jack rabbit (*Lepus c. californicus*) on the Gray Lodge Waterfowl Management Area, Butte County, California, the opportunity arose to examine jack rabbits which were killed periodically throughout every month of the year and at various times of the day. The time of death of many of the hares was not known but could be closely approximated for 160 of them. At necropsy, notes were made of the presence of fecal pellets in the stomach and the type of pellets in the rectum of each jack rabbit.

Rhythm of reingestion.—Figure 1 shows the percentage of jack rabbits with soft feces in the rectum and in the stomach over a 24-hour period. From this figure it can be seen that there is a daily rhythm of reingestion, the soft feces being produced and swallowed during the daylight hours. The samples used in constructing the histogram were collected in every month of the year and thus the periods of start and cessation of the formation of soft feces are unduly lengthened. Within any particular month the start or end of reingestion is more sharply delineated than is indicated. Nevertheless, the general picture remains the same, the formation and swallowing of the soft feces corresponding to the periods of inactivity of the jack rabbits. The major feeding period is at dusk and probably extends well into the night with another surge of feeding activity near dawn. As daylight approaches the hares begin to settle for the day and it is shortly after this time that the soft feces begin to be formed. Between 8:00 and 10:00 AM all the jack rabbits collected were producing soft feces and almost all had started to reingest. As the evening feeding period approaches, the soft feces are replaced in the rectum by the hard feces, but they may persist in the stomach for up to 4 hours later.

The transition from hard to soft feces in the rectum may be either gradual or sudden. Some jack rabbits were examined in which a transition from soft to hard feces could be noticed within the rectum, but in others there was a rather abrupt change from one type to the other. Similar cases are reported by Watson (1954) for the European rabbit in New Zealand. The soft feces in many of the

jack rabbits consisted of long strings of amorphous feces and could hardly be termed "pellets." It is entirely possible that at first examination one could be led to believe that the animals were suffering from diarrhea. Such amorphous feces appeared more often in jack rabbits collected in the morning hours, presumably at the start of the reingestion process. Most of the rounded soft feces occurred in the recta of hares collected in the afternoon and presumably near the end of the reingestion process.

The daily rhythm of reingestion exhibited by the jack rabbits in this study agrees in general with that noted for the European wild rabbit by Southern (1942), Watson (1954), and Meyer (1955), and for the European hare by Watson and Taylor (1955). There are, however, some differences. First, the length of time during which soft feces are retained in the stomach is apparently much shorter for the jack rabbit than for the European wild rabbit. Watson (1954) lists this time for the latter species as 9 hours, while it is closer to 4 hours for the jack rabbit. Second, the period of formation of soft feces in the rectum extends later into the afternoon in the jack rabbit than it does in the European rabbit or in the European hare.

Reingestion in young jack rabbits.—Watson (1954) states that the young of

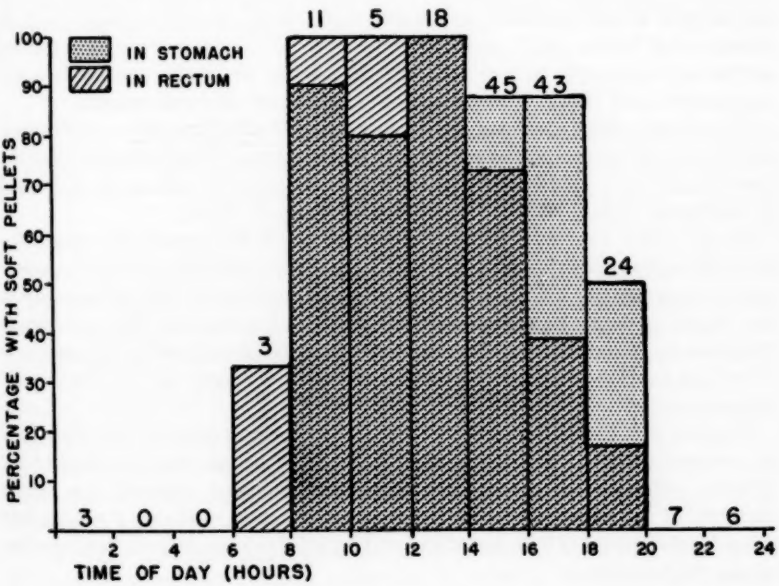

FIG. 1.—Percentage of jack rabbits with soft feces in the rectum and stomach over a 24-hour period. The numbers on the histogram are the numbers of jack rabbits in the sample from which each per cent was calculated.

the European wild rabbit start reingesting before they are completely weaned. During the present study several young jack rabbits were collected which had both milk curd and soft feces in their stomachs. The rectum of one of these had some green feces but that of another did not. The soft pellets in the stomach of the latter were very large in relation to the diameter of its rectum and it is suspected that this animal may have been eating the soft feces of its mother. If this is true, then there exists here an efficient method of passing the flora and fauna of the mother's intestinal tract to that of the offspring. The lack of such transfer from the mother may explain some of the difficulties encountered in raising young jack rabbits taken by Caesarean section from females shot in the field.

The process of swallowing the feces.—While making observations on the jack rabbits in the Gray Lodge population, several animals were observed apparently in the process of swallowing the soft feces. The position assumed most often was similar to that reported for the European wild rabbit by Watson (1954) and consisted of the animal bending its head down between the hind legs while in a squatting position. The actual act of taking the feces was never continuous but frequently was interrupted by pauses during which the hares resumed their normal position.

Discussion.—With the addition of the black-tailed jack rabbit to the list of lagomorphs which practice reingestion of soft feces, it now appears that, as Watson and Taylor (1955) have suggested, this phenomenon may be a normal feature of lagomorph biology. The process is by no means confined to the lagomorphs, and Harder (1949) claims that it occurs in most rodents.

The dietary significance of reingestion has not yet been fully established. Studies of the process in the domestic rabbit have shown that it may be associated with an enhancement of vitamin nutrition as well as an increased utilization of dietary nutrients (Thacker and Brandt, 1955).

Meyer (1955) found a definite seasonal increase in the practice of reingestion in the European wild rabbit in Australia which corresponded to the dry summer and autumn periods, and he postulated that it assumes a greater importance to the rabbits at times when the quality of the food degenerates. The samples in the present study do not indicate any seasonal trend of reingestion in the black-tailed jack rabbit. However, the numbers from each month are small and more extensive collections may be more enlightening.

The fact that young jack rabbits may start to reingest at about the time they are weaned suggests that the process is essential in one way or another for efficient utilization of green food. If, as the evidence suggests, the young jack rabbits eat some of the soft fecal pellets of their mothers, a mechanism exists for the spread of both beneficial and harmful organisms from the intestine of one to the other.

Summary.—Reingestion of soft feces is a normal part of the feeding biology of the black-tailed jack rabbit on the Gray Lodge Waterfowl Management Area, Butte County, California. The soft feces are formed in the caecum and

swallowed during the daylight hours, which are the main periods of inactivity of the hares. No seasonal trends in the process of reingestion could be detected.

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SEASONAL ABUNDANCE OF THE TICK *DERMACENTOR PARUMAPERTUS* ON THE BLACK-TAILED JACK RABBIT, WITH NOTES ON OTHER ECTOPARASITES

By M. Edwin Rosasco

Fremling and Gastfriend (1955) and Gastfriend (1955) studied the seasonal abundance and host relationships of the rabbit tick, *Dermacentor parumapertus*, on the black-tailed jack rabbit, *Lepus californicus deserticola*, in the Great Salt Lake Desert in Utah. It has been shown by Philip and Hughes (1953), Philip *et al.* (1955), and Allred *et al.* (in press) that ticks of this species are actual or potential vectors of tularemia, Colorado tick fever, and a rickettsial agent related to Rocky Mountain spotted fever. Roscoe (in press) has shown that this tick rarely bites man. From these data it is apparent that this tick is important in the maintenance of endemic diseases in rodents, rabbits, and indirectly, in man.

This study was conducted in order to continue the work of Fremling and Gastfriend (1955) and to supply additional information. The study area selected was a greasewood flat adjoining an active sand dune area approximately 3 miles southeast of Wig Mountain, Tooele County, Utah—about 4 miles northwest of the study area used by Fremling and Gastfriend.

From April 13, 1954 to April 13, 1955, five adult rabbits were shot each week, except that only four were taken during the last week in April, 1955, and none in the last three weeks of December, 1954. The dead rabbits were immediately placed in individual cloth sacks to prevent the escape of ectoparasites. They were maintained at a temperature of –10° F. for 72 hours to kill the ticks. After thawing, the rabbits were examined for ectoparasites; the sacks were also examined for any unattached specimens. Although most of the ticks were attached inside the ears of the rabbits, some were found around the base of the ears, eyelids, or other parts of the body.

Each tick was examined under a stereoscopic microscope in order to determine its sex, stage of development, and state of engorgement with blood. Individual records were kept of the numbers of larvae, nymphs, adult males and females collected from each rabbit.

RESULTS

A total of 7,330 ticks, *D. parumapertus,* was collected. The largest number (420) included 139 larvae, 265 nymphs, 7 adult males and 9 adult females found on a rabbit collected April 27, 1954.

Fleas, bot fly larvae, and two other species of ticks also were collected. One adult male tick, *Haemaphysalis leporis-palustris,* was collected on June 15 and another on October 5. Eight larval ticks, *Otobius lagophilus,* were collected November 2, and 52 nymphs on May 4, 11 and 25, November 24, January 11 and March 15. Twenty-one fleas of two species, *Pulex irritans* and *Hoplopsyllus anomalus,* were collected during the period from mid-October to mid-January. Twenty-eight mature bot fly larvae of the species *Cuterebra jellisoni* were collected during the period from the middle of June to the first week of September. Scars on the faces of the rabbits indicated that additional bot fly larvae had already emerged.

Larvae.—A total of 856 *Dermacentor* larvae was collected. Larvae first appeared during the middle of March and large numbers were present until the middle of May (Fig. 1). After the end of May, none were collected until the middle of September. According to Fremling and Gastfriend (1955: 163), "Moisture is essential to the immature forms, and the complete disappearance of the larvae during the extremely dry summer months indicates a period of estivation." The autumn population of larvae was much smaller than the population found during the moist spring months.

The larvae did not begin to engorge until the middle of April. Until the end of May, most of those that were collected were engorged. None of the larvae collected in autumn were engorged.

According to Fremling and Gastfriend it is possible that the spring larval population was derived from the hatching of eggs which overwintered; the fall larval population may have been larvae which estivated after failing to find a host the preceding spring and/or larvae which hatched from eggs deposited by females early in the season.

Nymphs.—A total of 3,006 nymphs was collected. Nymphs first appeared during the middle of January, were absent in February, and recurred the first week of March (Fig. 1). They were most numerous during April, May and June and disappeared completely after the first week of July. Nymphs appeared again during the first week of September and were present until the middle of November. During the autumn, the largest numbers were collected during

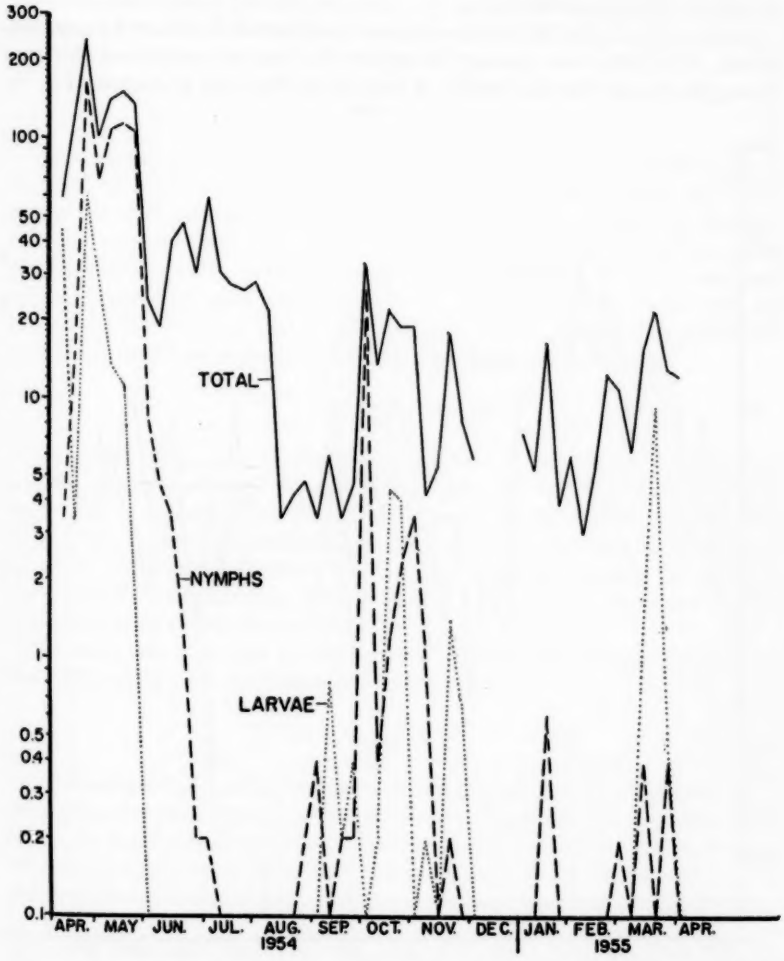

FIG. 1.—Average numbers of larvae and nymphs and total numbers of all stages of the tick *Dermacentor parumapertus* per rabbit each week from April 13, 1954 to April 13, 1955.

the first week of October. The autumn population was much smaller than the population found during the moist spring months.

A few nymphs were found engorged during January and March; most of them engorged during the period from the middle of April to the first week of July. Nymphs collected during the autumn were not engorged. According to Fremling and Gastfriend (1955), the autumn population of nymphs probably developed from larvae which molted following estivation and found a host before the advent of cold weather.

Adults.—Totals of 2,049 adult male and 1,419 adult female ticks were collected. Adult ticks were present throughout the year but were most abundant during the period from the middle of May to the first part of August (Fig. 2).

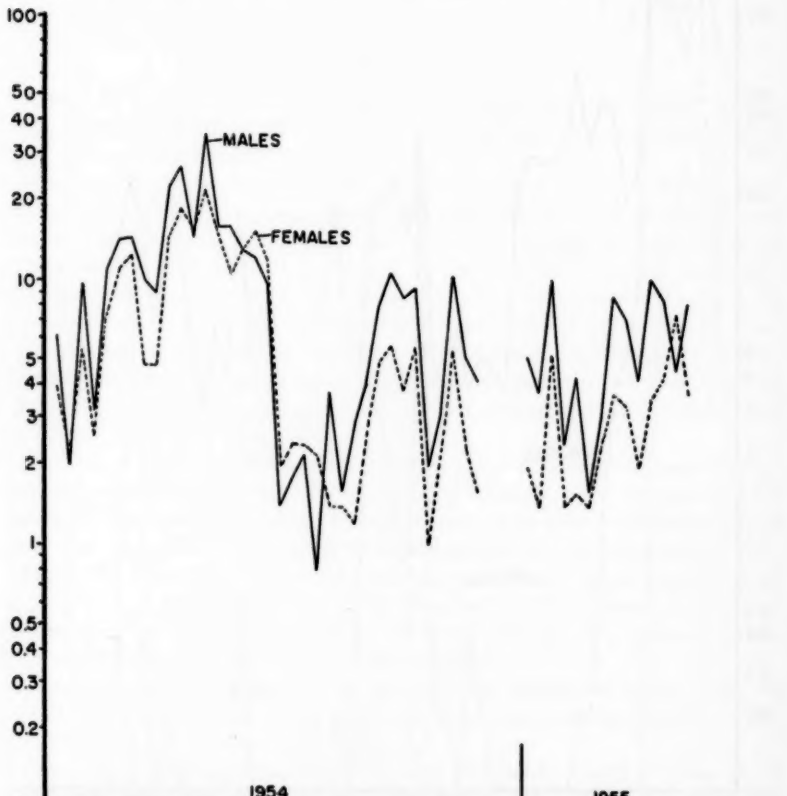

FIG. 2.—Average numbers of adult male and female ticks, *Dermacentor parumapertus*, per rabbit each week from April 13, 1954 to April 13, 1955.

This peak population of adult ticks was derived primarily from the spring nymphal population; some of the adults may have been those which survived from the previous season. In general, males were more numerous than females except during the period from the end of July to the first week in September.

No adult male ticks were found engorged with blood. Engorged female ticks were first noticed during the middle of May, and most of them were engorged during the period from the last week of July to the fourth week of August. None were engorged during the rest of the year except for one found on September 21. Adult male and female ticks were found in mating position as early as the second week of May.

DISCUSSION

The seasonal fluctuations of larvae, nymphs and adults are similar to those recorded by Fremling and Gastfriend. The 856 larvae taken were only 28 per cent of the total number of 3,006 nymphs collected from rabbits. On the same basis, the nymphs equal only 87 per cent of the adult population. Coffey (1954) and Gastfriend (1955) have shown that the immature stages of this tick infest many species of rodents. Kangaroo rats of the species *Dipodomys ordii* and *D. microps* are the most heavily infested rodents in this area. Few adult ticks have been found on rodents or mammals other than the leporids.

ACKNOWLEDGMENTS

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SUMMARY

Adult ticks of the species *Dermacentor parumapertus* were present on rabbits throughout the year, but were most abundant during the period from the middle of May to early August and least numerous thereafter until October. Nymphs were most numerous in April, May and June, were absent in July and August, and reappeared in the autumn. Larvae were most abundant during the moist months of April and May, were absent during the dry summer months, and reappeared in smaller numbers in the autumn. Larval numbers collected from rabbits were only equal to 28 per cent of the 3,006 nymphs collected. The nymphs were only equal to 87 per cent of the 3,468 adult ticks.

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ECOLOGICAL NOTES ON THE MAMMALS OF BERNALILLO COUNTY, NEW MEXICO

BY R. DEWITT IVEY

Bernalillo County is a nearly rectangular area, measuring approximately 40 by 80 miles and located in north-central New Mexico. Aside from being a center of population, agriculture, and historical interest, the area deserves attention because of its fortunate combination of geographic features. It is almost evenly bisected into east and west halves by the Rio Grande. The eastern half includes a section of the Sandia and Manzano mountain ranges, while the western half consists of high mesas and a small desert river, the Rio Puerco. With its long axis running east and west, the county itself makes a transect across these formations.

This paper is a progress report summarizing notes on the ecological distribution of mammals collected intermittently between September, 1947, and June, 1956, by the writer. About 6,000 trap-nights in 23 localities form the basis of the report. Trapping was principally with small metal live traps of the Sherman type. These were set approximately 10 yards apart in lines running through typical communities or along ecotonal belts. Bait was generally a mealy mixture of rolled oats, bacon, raisins, and peanut butter, run through a meat grinder, with the occasional addition of carrots, celery, frozen fish, and grasshoppers. Steel trapping, sight records, road kills, and specimens found dead by the writer or his students contributed supplementary information.

Chief emphasis was on sampling a variety of habitats for the presence or absence of ecologically significant species. The study omits the larger mammals. Work on game and furbearing species in the Sandia Mountains was omitted

because of refuge regulations. An incalculable error in the data is due to the limitations of the collecting methods themselves.

A grant-in-aid from the New Mexico Academy of Sciences in 1953 provided much of the equipment used in the latter portions of this study. Grants-in-aid from the University of New Mexico were of assistance during the 1947-49 period. Bats of the *Myotis* group were identified by Luis de la Torre of the Chicago Natural History Museum. Permits to collect protected species in non-refuge areas were helpfully provided by the New Mexico Department of Game and Fish.

A combination of life zone and biological community names is used in describing the habitats of mammals in this account. Although the Life Zones of Merriam (Nat. Geog. Mag., vol. 6, 1894) are open to several valid criticisms, they nevertheless provide convenient calling names for certain ecological conditions, particularly in the Southwest. The criteria used herein for distinguishing them are not temperature data, but characteristic plants. Three life zones are present to their full extent in the county, each containing a number of biological communities. A tendency toward Lower Sonoran conditions in the Rio Grande Valley, and toward Hudsonian conditions on Sandia Crest may justify consideration of two more life zones in this area.

Biological communities are probably of greater validity than life zones in describing the ecological distribution of mammals. Some species are confined to a single community. Others occupy a group of ecologically similar or geographically adjacent communities. About twenty of the more important biological communities found in Bernalillo County are included in the outline below. Space does not permit a thorough description of each. Instead, the briefest characterization is given, in the hope that it will correctly identify the community in the minds of those who may wish to investigate it further.

OUTLINE OF LIFE ZONES AND COMMUNITIES

CANADIAN ZONE: 8,000 to 10,678 feet

- **Stunted conifers:** some areas over 10,600 feet; limber pine (*Pinus flexilis*), Douglas fir (*Pseudotsuga taxifolia*); may justify suspicion of some HUDSONIAN ZONE conditions
- **Spruce-fir forest:** 9,800 to 10,678 feet; Douglas fir, Engelmann spruce (*Picea engelmanni*)
- **White fir forest:** 8,000 to 9,800 feet; *Abies concolor*
- **Aspen forest:** 8,000 to 10,678 feet; quaking aspen (*Populus tremuloides*)
- **Meadow:** 8,000 to 10,670 feet; bluegrass (*Poa pratensis*) and other meadow grasses
- **Gambel oak scrub:** 7,300 to about 10,000 feet; *Quercus gambeli*; usually on dry, warm slopes

TRANSITION ZONE: 7,300 to 8,000 feet

- **Yellow pine forest:** 7,300 to 8,000 feet; *Pinus ponderosa*
- **Gambel oak scrub:** as described above

UPPER SONORAN ZONE: 4,800 to 7,300 feet

Piñon-juniper woodland: 5,800 to 7,300 feet; piñon (*Pinus edulis*), one-seeded juniper (*Juniperus monosperma*), and blue grama grass (*Bouteloua gracilis*); occupying foothills and high mesas

Short grass range: 5,000 to 5,800 feet; black grama (*Bouteloua eriopoda*) and blue grama; best condition of range; occupying mesas and alluvial slopes

Overgrazed range: same altitudes; snakeweed (*Gutierrezia sarothrae*), tumbleweed (*Salsola kali*), and burrograss (*Scleropogon brevifolius*); most widespread community in the county

Sanddrift-shrub area: same altitudes; shadscale (*Atriplex canescens*), nightshade (*Solanum elaeagnifolium*); the last stage of range deterioration, with moving sand and desert shrubs

Arid rock slope: 5,000 to 9,000 feet; mountain mahogany (*Cercocarpus montanus*), scrub oak (*Quercus turbinella*); hot, dry, steep, boulder-strewn slopes on canyon sides, talus and rimrock areas

Alluvial fan and canyon bottom: 5,800 to 7,000 feet; dense stands of rabbit brush (*Chrysothamnus nauseosus*) or cane cactus (*Opuntia imbricata*)

Arroyo: 4,900 to 5,800 feet; Apache plume (*Fallugia paradoxa*), rabbit brush, and hoe grass (*Muhlenbergia porteri*)

Cottonwood forest: below 5,000 feet; *Populus wislizenii*; river floodplain

Tamarisk-saltgrass flat: same altitude and situation; tamarisk (*Tamarix pentandra*) and saltgrass (*Distichlis stricta*)

Russian olive thicket: same altitude and situation; *Elaeagnus angustifolia*

Aquatic or marshy area: same altitude; cattail (*Typha latifolia*), various willows; river banks, ditches, ponds

LOWER SONORAN ZONE: some areas below 5,800 feet and possibly most areas below 5,000 feet

Lava bank: 5,600 feet; dark, volcanic boulders with vegetation similar to that of Arid rock slope, above

Mesquite: 5,200 to 5,600 feet; several arroyos on lower alluvial slopes with stands of mesquite (*Prosopis juliflora*)

(The last four communities under Upper Sonoran are equally characteristic of this life zone.)

ACCOUNTS OF SPECIES

In the following accounts dates of capture are omitted except for species captured rarely. Locality numbers refer to positions on the map (Fig. 1). For the most part, subspecific names are assumed from ranges as outlined by Miller and Kellogg (U.S. Nat. Mus. Bull. 205, 1955).

Myotis t. thysanodes Miller. Fringed bat.—A specimen of this species, obtained from a cave in the Sandia Mountains, was donated by a student in the fall of 1952.

Myotis y. yumanensis (H. Allen). Yuma bat.—A specimen of this species, obtained from a cave in the Sandia Mountains, was donated by a student on May 25, 1953.

Lasionycteris noctivagans (Le Conte). Silver-haired bat.—One specimen of this species was found dead in an Albuquerque yard in September, 1952. Another specimen was shot over a pond in the Rio Grande valley on June 19, 1956.

Corynorhinus rafinesquei pallescens Miller. Pallid lump-nosed bat.—A specimen of this species was found dead in an Albuquerque yard in the fall of 1951. Another individual was seen clearly on the roof of a cave at the north end of the Sandia Mountains on June 23, 1956, locality 35.

Antrozous p. pallidus (Le Conte). Pale bat.—A specimen of this species was donated by Henry Schrieber, August 1, 1955. The bat was caught in his yard in the Rio Grande valley at Albuquerque. Another individual of this species was seen on the roof of a cave at the north end of the Sandia Mountains (35) on June 23, 1956.

Tadarida mexicana (Saussure). Mexican free-tailed bat.—Living or mummified specimens of this bat are periodically brought in by students of the writer. Some have been taken in farm buildings, others found dead in yards in Albuquerque and the Rio Grande valley.

Lepus californicus texianus Waterhouse. Texas jackrabbit.—This Sonoran species is found in most habitats from river bottom (4,800 feet) to piñon-juniper foothills (7,000 feet). They were most often encountered in the arroyos of the long alluvial slopes forming the sides of the Rio Grande and Rio Puerco valleys, and on the salt grass-tamarisk flats of the river bottom. In the arroyos their

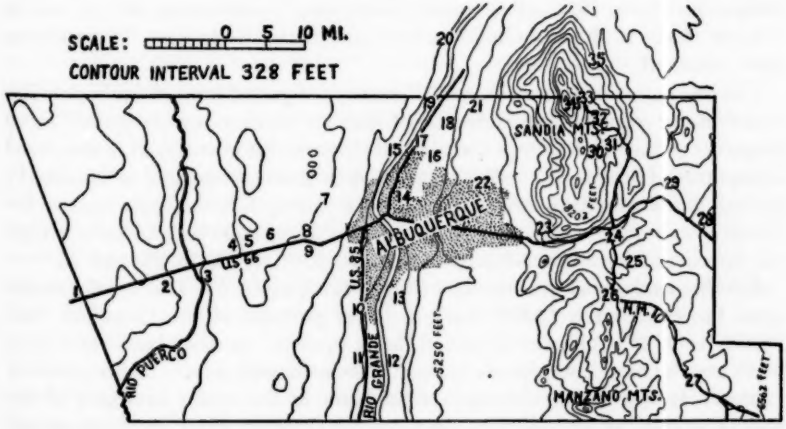

FIG. 1.—Map of Bernalillo County, New Mexico, with adjacent portions of Sandoval County. Numbers indicate localities to which reference is made in the text.

forms are often located under such brushy cover as Apache plume and hoe grass. Records include two specimens, five dated sight records, a road kill, and numerous undated recollections, from localities 1, 5, 10, 12, 13, 22, and 24.

Sylvilagus floridanus cognatus Nelson. Manzano mountain cottontail.—A fragmentary specimen was obtained at 8,500 feet in the white fir forest on the eastern slope of the Sandia Mountains, locality 32, April 22, 1956. As it was found dead on a road, only a partial skin and skull were salvaged. A juvenile cottontail was seen at 11,650 feet near Sandia Crest (34) on May 12, 1956. It entered a den of rocks in a roadbank in the spruce-fir forest. Although positive identification was not possible, it seems probable that this rabbit was also of this species. If so, its range appears to fill at least the Canadian zone coniferous forests of the Sandia Mountains.

Sylvilagus audubonii cedrophilus Nelson. Cedarbelt cottontail.—These rabbits are found throughout the Sonoran zones of the county. They are especially numerous at times in eroded hillsides cut with many gullies and arroyos. They were also recorded from cottonwood forests, Russian olive thickets, willow thickets, tamarisk-saltgrass flats, arid rock slopes, overgrazed mesa, among the cane cactus and rabbit brush of alluvial fans, and in sanddrift-shrub areas. Records are: eight specimens, six sight records, from localities 1, 4, 5, 7, 13, 15, 16, and 23.

Cynomys sp. Prairie dog.—These animals are at present very scarce in the county because of rodent control measures. Their colonies are widely scattered and very small, except where they occur so close to urban areas that controls are not possible. In 1948 there were colonies in the vicinity of the University Golf Course, now within the city of Albuquerque. A fair-sized colony, apparently of the species *gunnisoni,* occupied a piece of vacant valley land well within the city in 1951. Old, unused prairie dog burrows may still be seen in various places in the Rio Grande valley and on nearby mesas. No specimens were obtained.

Citellus spilosoma marginatus (V. Bailey). Spotted ground squirrel.—This is one of the mammals characteristic of the vast expanses of overgrazed sheep range occurring on mesa tops and alluvial slopes of the country. It is also found along arroyo bottoms and banks, on good black grama range, and on hummocky ground of the sanddrift-shrub type. Thus, it largely fills the open country between river bottom and foothills, at altitudes of from 4,900 to 5,800 feet. Thirty-one specimens were observed, from localities 5, 9, 13, 14, 15, 22, and 23.

Citellus variegatus grammurus (Say). Rock squirrel.—This species occurs from Lower Sonoran (4,800 feet) to lower portions of the Canadian Zone (8,400 feet). It might well be called "bank squirrel," as steep banks of rock or earth are the most conspicuous feature associated with nearly all its points of capture. It was recorded from a road bank in the white fir forest of the Sandia Mountains, on arid rock slopes of the foothills, along the bottoms and banks of arroyos adjacent to the river bottom, and along dikes and ditch banks throughout the irrigated Rio Grande Valley. One was observed in a cotton-

wood forest, pursued by a Cooper's hawk. Another was dead on a street in the heart of Albuquerque. Records consist of two specimens, two road kills, and seven sight records from localities 7, 14, 15, 16, and 32.

Citellus leucurus pennipes (A. H. Howell). White-tailed antelope squirrel.—A single specimen of this species was trapped at locality 1. The location was an arid sandstone rimrock, with scattered mountain mahogany and juniper shrubs.

Citellus interpres (Merriam). Texas antelope squirrel.—This antelope squirrel was taken in rocky, arid foothills and talus slopes of the Sandia foothills, where mountain mahogany is characteristic. These are Upper Sonoran areas at about 6,000 feet. Specimens observed by the writer were two from Embudo Canyon and two from Tijeras Canyon, near locality 23.

Eutamias q. quadrivittatus (Say). Colorado chipmunk.—This chipmunk was taken in various communities from the piñon-juniper belt of the Upper Sonoran (6,000 feet) to the middle of the Canadian Zone (9,500 feet). It seems especially to like semi-open woodlands or sunlit portions of the forest floor where windfalls or rocks provide elevated perches and cover. This species reaches altitudes in the Sandias occupied by *minimus* farther north. Specimens were taken in arid rock slopes, piñon-juniper foothills, Gambel oak scrub, white fir, and mixed white and Douglas fir forests. Fourteen specimens were observed, from localities 23, 25, 26, 29, 32, and 33.

Sciurus aberti Woodhouse. Tassel-eared squirrel.—Introduced into the Sandia Mountains, these squirrels are frequently seen along mountain roads of the yellow pine and white fir forests. They were conspicuously absent from those pine forests of the Manzano Mountains visited by the writer, where the ground was littered with a rich crop of unchewed cones. Nine sight records were obtained at altitudes of from 7,300 to 8,750 feet, at localities 30, 31, 32, and 33. Their range thus appears to be the coniferous forests of the Transition and the lower Canadian zones.

Tamiasciurus hudsonicus mogollonensis (Mearns). Spruce squirrel.—Two of these large, red-backed spruce squirrels were observed at close range, at 9,500 feet in the Sandia Mountains, on April 20, 1956. The situation was a white fir forest with scattered Douglas firs, at locality 33. A large hollow log, stuffed with the scales and green sprigs of firs appeared to be the den of these animals. The characteristic warrens of these squirrels were more abundant at, and somewhat below, Sandia Crest, in the Douglas-fir-Englemann spruce forest. Their range would thus appear to be the upper half of the Canadian zone coniferous forest.

Thomomys bottae connectens Hall. Valley pocket gopher.—These animals are abundant in the Rio Grande valley, in old fields, tamarisk-saltgrass flats, and yards in residential districts. On the mesas and alluvial slopes they have scattered colonies, especially in areas of denser vegetation and softer soils, as along arroyo bottoms and fencerows. Nine specimens observed were from localities

5, 7, 13, 14, and 15. Three skulls of *bottae* found in owl pellets at locality 7 are probably of this race.

Thomomys bottae actuosus Kelson. Pocket gopher.—Diggings of these gophers are common in meadows and fields of cultivated valleys in the lower parts of the mountains. They were also observed in grassy (blue grama) and brushy canyon bottoms of the piñon-juniper foothills. Two specimens were collected from localities 24 and 25.

Perognathus f. flavus Baird. Silky pocket mouse.—This mouse is one of those few species able to live on the open mesa. It was found living on good grama range, overgrazed range, and sanddrift-shrub areas, apparently preferring the latter two conditions. Casual observations over a nine-year period indicated a marked increase in this species during a drought of several years duration, apparently at the expense of *Peromyscus maniculatus* in some areas. During a period of grid trapping, these mice were rarely recaught in live traps, indicating the possibility of a transient existence, at least during late summer. In seven cases, pairs of these mice were caught in the same live trap, suggesting that they were traveling in pairs, or in search of mates. Sixty-one specimens were observed, from localities 4, 5, 7, 8, 15, and 20. Eight skulls were obtained from owl pellets at locality 7.

Perognathus a. apache Merriam. Apache pocket mouse.—A skull of this species was found in pellets apparently of the barn owl at locality 7 on August 23, 1951. The location is an outcrop of volcanic rock surrounded by open mesa and alluvial slope of the heavily overgrazed type.

Perognathus i. intermedius Merriam. Rock pocket mouse.—Two specimens of this species were taken by the writer at locality 7 on August 5, 1951. Skulls were also obtained from owl pellets in the same locality. The habitat is a rimrock and talus slope of dark volcanic rocks. Specimens were obtained from traps placed in crevices in the rimrock appearing to be dens. Probably the heat-absorbing qualities of these dark rocks create artificial Lower Sonoran conditions for this mouse and for *Dipodomys m. merriami*, which was taken in adjacent arroyos filled with mesquite.

Dipodomys spectabilis baileyi Goldman. Bannertail kangaroo rat.—This large kangaroo rat is usually characteristic of Upper and Lower Sonoran mesas, especially of the overgrazed type. The only specimens taken by the writer in the county were three from locality 6, in a typical mesa area. Six skulls were obtained from owl pellets at locality 7.

Dipodomys m. merriami Mearns. Merriam kangaroo rat.—Typically Lower Sonoran, this rat was found in mesquite-filled arroyos adjacent to a bank of dark lava boulders, at locality 7. It was also taken in a rimrock outcrop of buffy sandstone facing southwest, at locality 1. It is possible that proximity of these warm rocks, or the lack of cold air drainage in adjacent arroyos, create conditions favorable to this animal and to the mesquite plant. Judging by trapping results, this species was much less abundant than *ordii* at locality 7, where both occur.

Dipodomys ordii Woodhouse. Ord's five-toed kangaroo rat.—One of the characteristic species of the open range land, this rat occupies typical overgrazed mesa, good black grama range, sanddrift-shrub areas, and penetrates the edges of tamarisk-saltgrass flats of the Rio Grande bottomland. The specimens obtained were mostly from areas of subspecific intergradation. Fifty-eight specimens were observed, from localities 1, 3, 5, 7, 8, 15, 20 and 23. In addition, 19 skulls were obtained from owl pellets at locality 7.

Castor canadensis mexicanus V. Bailey. Rio Grande beaver.—Beavers are common in the larger drainage ditches of the Rio Grande valley and along the river itself. Cottonwood and willow seem to be the chief plants utilized. Cottonwoods up to 18 inches in diameter are felled. Their homes are nearly always large burrows in the banks of the river or ditches. One typical house, rather old and unused, was found beside the river (17) indicating that the house-building instinct is not totally absent from this population. Although dams are not usually allowed to remain for long in the irrigation and drainage ditches, five were recorded near localities 19 and 15 on various dates. The only specimen secured by the writer was a skull from a beaver taken at locality 19 by Christopher Fitzgerald of Corrales, a professional trapper.

Reithrodontomys megalotis aztecus J. A. Allen. Western harvest mouse.—Harvest mice were taken throughout the Upper Sonoran zone, from 4,900 to 8,300 feet. They occupy disturbed or ecotonal areas for the most part, rather than typical habitats. They were fairly common on the tamarisk-saltgrass flats of the river floodplain, and on badly deteriorated range with shifting sand and shrubby cover. They were also taken on rocky roadbanks in the piñon-juniper and white fir forests, from a gully on an alluvial slope, under the rabbit brush of a canyon bottom, and from great horned owl pellets. Twenty-one specimens were obtained from localities 4, 7, 8, 15, 20, 25, 28, and 32.

Peromyscus maniculatus rufinus (Merriam). Deer mouse.—The deer mouse was taken in many communities from Sandia Crest down to brushy areas adjacent to the Rio Grande bottomland. Records are from stunted limber pine ledges at Sandia Crest, Douglas fir-Engelmann spruce forest, aspen forest, white fir forest, mountain meadow, yellow pine forest, Gambel oak scrub, brushy canyon bottom, piñon-juniper woodland, arid rock slopes, brushy gullies on the alluvial slopes, in outcrops of volcanic and sandstone rimrock in mesa areas, and in sanddrift-shrub areas. These adaptable mice appear to fill in any habitat not fully occupied by more specialized species. In some communities, whether by default or by competition, they are the most abundant species, as at Sandia Crest (34) and in the spruce-fir and white fir forests. In others they are a less common or even rare species. They appear to give way completely to more drought-hardy species on typical, undisturbed mesa, and to *P. leucopus* in the river bottomlands. The population at Sandia Crest was remarkably uniform, and of typical *rufinus* appearance, although lacking the rich color of that race in the Jemez Mountains. At 8,300 feet about one specimen in five tends toward the paler color of *blandus*, while specimens from non-mountain areas are gen-

erally of a paler coloration. Records include 73 specimens from localities 1, 4, 7, 25, 32, 33, and 34.

Peromyscus leucopus tornillo Mearns. White-footed mouse.—This species is most characteristic of river bottom communities, including tamarisk-saltgrass flats, Russian olive thickets, margins of lagoons, cattail marsh, cottonwood forests and nearby lower mesa slopes of the sanddrift-shrub type. One was from a gully high on an alluvial slope; another was from an arid rock slope at the western edge of the Sandia Mountains. Records include 51 specimens from localities 2, 4, 12, 15, 17, and 23.

Peromyscus boylii rowleyi (J. A. Allen). Brush mouse.—This mouse was taken principally on arid, rocky and brushy slopes, such as the boulder-strewn western foothills of the Sandia Mountains, and in rocky gullies on the alluvial slope east of the Rio Puerco. Seven specimens were taken at localities 23 and 26.

Peromyscus t. truei (Shufeldt). Piñon mouse.—This species justly deserves the name piñon mouse. It was by far the most abundantly captured species in the piñon-juniper foothills. It is quite active on the snow in winter in these woodlands, and its tracks far outnumber those of its two associates, the chipmunk and the deer mouse. Specimens were also taken from the lower edge of the Canadian zone (mixed white fir and Gambel oak), from eroded gullies on the alluvial slope near the Rio Puerco, and from arid, rocky outcrops of sandstone and lava, in open country. Thirty-two specimens were obtained from localities 1, 4, 7, 25, 26, 28 and 32.

Peromyscus n. nasutus (J. A. Allen). Rock mouse.—This species accompanies *truei* in piñon-juniper areas. It was also taken in rocky and brushy gullies on an alluvial slope. Four specimens were obtained at localities 4 and 28.

Onychomys leucogaster pallescens Merriam. Grasshopper mouse.—Grasshopper mice are characteristic of the Upper Sonoran open range country and adjacent arid hills and bottomlands. They were found on good black grama range, on overgrazed range, in sanddrift-shrub areas, and on sandy ridges and banks in the river bottom. They were also taken among the lower granite boulders of the Sandia foothills, and in dark lava rocks west of Albuquerque. Records include 37 specimens from localities 4, 5, 7, 8, 15, 20 and 23.

Sigmodon minimus woodi Gardner. Least cotton rat.—A specimen of this species was found dead on the highway at locality 11 on October 8, 1948. The surrounding area was a mixture of saltgrass flats and marshy ditches.

Neotoma micropus canescens J. A. Allen. Hoary wood rat.—This is the wood rat of open country in the Upper and Lower Sonoran zones of the county. It is one of the characteristic mammals of the arid short grass ranges, of overgrazed range, and of alluvial fans along the edges of the mountains. It generally stops at the first foothill, where *albigula* takes over. It is especially abundant in dense stands of cane cactus and prickly pear cactus, which it eats extensively, apparently for water. Nests are made under shrubby cover such as cane cactus or rabbit brush, and consist of piles of dead cane cactus or other twigs, horse manure, and bones. The whole area is generally littered and its burrow paved

with rosettes of cactus thorns which it has skillfully avoided in eating the succulent body of the plant. When pursued, it readily climbs the cactus shrubs to escape. On one such occasion the feet were observed to bleed from the thorns. Twelve specimens were observed, from localities 1, 5, 6 and 23.

Neotoma a. albigula Hartley. White-throated wood rat.—This Upper Sonoran wood rat was found chiefly around the skirts of the mountains, on the arid rock slopes, and in rocky outcrops in the piñon-juniper foothills. Where the foothills reach level ground, however, it gives way to *micropus*. It is absent from open country except in scattered rimrock formations of sandstone and lava. Eleven specimens were observed from localities 1, 7, 23 and 25.

Neotoma mexicana fallax Merriam. Mexican wood rat.—A specimen of this species was obtained in the Sandia Mountains, near Sandia Crest (34), on May 13, 1956. The situation was an obvious wood rat habitation in a pile of old logs at 10,500 feet in the Douglas fir-Engelmann spruce forest. The specimen was of somewhat more robust size and paler coloration than specimens observed by the writer from the northern part of the state.

Microtus longicaudus (Merriam). Long-tailed meadow mouse.—This mouse was recorded in meadow, grassy canyon bottom, white fir forest, spruce-fir forest, oak scrub, and under limber pines at Sandia Crest. Thus, it appears to inhabit forested regions freely in the absence of *Clethrionomys* and *Phenacomys*. Records include 17 specimens from localities 32, 33 and 34.

Ondatra zibethicus osoyoosensis (Lord). Muskrat.—Muskrats are common throughout the waterways of the Rio Grande valley irrigation system. They are especially abundant along the clear drainage ditches. As an example, nine were taken in 14 traps in a single night. They are present but less abundant in the opaquely muddy waters of the Rio Grande and the irrigation ditches and in quiet or stagnant ponds and lagoons. They are even found along the smaller ditches in semi-residential areas of Albuquerque, where they are sometimes killed on the streets.

Rattus norvegicus (Berkenhout). Norway rat.—Five of these rats were taken in steel traps set for muskrats at the entrances of underwater burrows at locality 16. This adaptable species is apparently occupying some of the county's marsh and bank areas in the absence of a true marsh rat.

Mus musculus Linnaeus. House mouse.—A feral house mouse was taken on a lower mesa slope near the Rio Grande bottomland in a sanddrift-shrub situation. Another was taken in a river bottom tamarisk-saltgrass flat. These specimens are from localities 15 and 20.

Erethizon dorsatum (Linnaeus). Yellow-haired porcupine.—Although most characteristic of the coniferous forests, porcupines were recorded from the lowest to the highest points in the county. On May 2, 1954, a porcupine was observed in a young cottonwood tree in the Rio Grande bottomland, locality 15. On May 13, 1956, one was observed at Sandia Crest in the Douglas fir-Engelmann spruce forest at about 11,650 feet, locality 34. A specimen was obtained from a more typical habitat, the piñon-juniper association, locality 25. Records

from other parts of the state indicate that these animals even wander out of forested regions onto nearby mesas (Cuba, N. M., Oct., 1947), and above timberline (Santa Fe Baldy, 12,000 feet, May 30, 1954).

Vulpes macrotis neomexicana Merriam. New Mexico desert fox.—Records of this animal were limited to typical mesa areas. One was found dead on a road at locality 5. The surrounding country was flat, overgrazed mesa. Another was found dead in an arroyo of the alluvial slope at locality 8. Small fox-type tracks, probably of this species, are frequently seen in arroyos of the alluvial slope east of Albuquerque, in sanddrift-shrub areas and other open portions of the county.

Urocyon cinereoargenteus scottii Mearns. Arizona gray fox.—Two sight records of the gray fox in Bernalillo County and two in nearby areas indicate it to be a forest-inhabiting species, in contrast to the desert fox. One record from the yellow pine forest (31), two from piñon-juniper woodlands (27 and 35), and one from river bottom farmland (near Los Lunas, about 10 miles south of the county line), adjacent to hedgerows and cottonwoods, give an idea of its habitat.

Bassariscus astutus flavus Rhoads. Ringtail.—A sight record of the ringtail was reported by Henry Schrieber from locality 27, in piñon-juniper foothills east of the Manzano Mountains. Tracks believed to be of this species were present in Sandia Cave, at the north end of the Sandia Mountains (35). It is probably of general distribution on cliffs, talus slopes and rimrocks of the Upper Sonoran and Transition zones.

Procyon lotor mexicanus Baird. Mexican raccoon.—While no specimens were taken, the unmistakable tracks of raccoons were frequently found along the muddy banks of the Rio Grande and many of its tributary ditches. Raccoons are found in the Canadian zone in other parts of New Mexico, but the near absence of streams in the Sandia Mountains may limit them in this region.

Mustela erminea muricus (Bangs). Short-tailed weasel.—A weasel believed to be of this species was observed in the Sandia Mountains on April 21, 1956. The front half of its body, except for the feet, was observed clearly at 10 feet for about a minute. The small size, chocolate brown back and white underparts suggest the female short-tailed weasel. Although small, it was definitely larger than the least weasel, and it was clearly not the large, pale, bridled weasel of the valley. The habitat was a forest of white and Douglas fir at 9,500 feet, locality 33.

Mustela frenata neomexicana (Barber and Cockerell). New Mexico bridled weasel.—According to a game department worker who brought a live specimen of the bridled weasel to the Department of Biology of the University of New Mexico, weasels of this species are caught at the rate of two or three a year by skunk trappers during predator control operations in the agricultural areas of the Rio Grande valley.

Taxidea taxus berlandieri Baird. Badger.—Badgers are characteristic of the mesa areas of the county, although in adjacent counties they were noted in

the river bottom and in the piñon-juniper foothills. A skull was obtained from a specimen found dead in an arroyo of the alluvial slope west of Albuquerque (8). Another was killed on a street in northeastern Albuquerque (22), near the edge of town. Another was found dead on the highway a few miles east of locality 28, in piñon-juniper foothills. Tracks and diggings of badgers were noted frequently on the alluvial slope east of Albuquerque, locality 22.

Mephitis mephitis varians Gray. Striped skunk.—These skunks are so common as to be a nuisance in the Rio Grande valley. A sight record was obtained from under a stand of cottonwoods (18). Specimens were obtained from an irrigation ditch bank (19) and from a bank of volcanic rocks on an alluvial slope (7). Road kills were noted from a sanddrift-shrub area (15) and open mesa (21). Thus its range appears to fill at least the Upper Sonoran zone of the county.

DISCUSSION

The Sandia-Manzano mountain range is interesting because of the poverty of its fauna. Located only 50 miles south of the true Rocky Mountains and reaching an altitude of 10,678 feet, it duplicates many conditions found in the more northern mountains. It is surprising not to find such mountain species as the snowshoe rabbit, bushy-tailed wood rat, red-backed mouse, *Phenacomys intermedius*, golden-mantled ground squirrel, pika, and until recently, tassel-eared squirrel, occupying their characteristic niches. Some of these species may yet be discovered in these mountains, and others may be explained away on the basis of unfavorable conditions today. There is nevertheless an over-all faunistic picture suggesting that since the montane associations of these mountains became isolated from those of the Sangre de Cristo range, drought or other conditions catastrophic to mammal populations have greatly depleted the fauna. That these mountains now offer unexploited opportunities for mammal life is indicated by the numerous unchewed pine cones of some Transition zone forests and the successful introduction of tassel-eared squirrels in the Sandias. In the Canadian zone, meadow mice appear to have occupied territory in which red-backed voles or *Phenacomys* would be found farther north and the Mexican wood rat occupies situations where bushy-tails might be expected.

While the plant associations, and therefore the life zones characterized by them, occur at somewhat higher altitudes in this region than in the mountains of northern New Mexico, a number of mammals have ranges that extended much higher than expected. These include the tassel-eared squirrel, Mexican wood rat, cottontail rabbit, Colorado chipmunk, and *Peromyscus truei*. These facts and the occurrence of meadow mice and Mexican wood rats in the darkest parts of the coniferous forests may indicate a movement toward conditions of greater humidity. Or it may represent their occupancy of montane ecologic niches in the absence of a more complete fauna of mountain mammals.

In marshy areas of the Rio Grande valley, the absence of true marsh-dwelling

species was noticed. The temporary nature of such areas may account for this lack. *Peromyscus leucopus* and *Reithrodontomys*, which can also live under dry conditions, appear to be the chief occupants of marshes and banks. Muskrats and beavers occupy more truly aquatic conditions in the irrigation and drainage ditches. House mice and Norway rats have moved into ditch-bank areas. *Sigmodon minimus* is present but rare or of unequal distribution in the county. Possibly its invasion is so new it has not had time to populate the region.

Elsewhere than in these areas, the county possesses a comparatively rich mammal fauna. This is due in part to the interdigitation of Upper and Lower Sonoran conditions and in part to the meeting of great plains and intermountain forms. The Rio Grande valley is doubtless a highway of northward migration in these postglacial times, and may well be watched for the appearance of southern species extending their ranges.

SUMMARY

Bernalillo County, New Mexico, contains a mixture of mountains, high plains or mesas, alluvial slopes, rocky outcrops, and river valleys. Twenty major biological communities and four life zones existing in this area are considered in the present paper. The occurrence or ecological distribution of fifty kinds of mammals in these habitats is discussed.

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THE EFFECT OF VARIATION IN HUMIDITY AND WATER INTAKE ON ACTIVITY OF *DIPODOMYS*

By Richard Nichter

Kangaroo rats were observed to be more active when fed only dry grain than when given succulents in their diet (Schmidt-Nielsen and Schmidt-Nielsen, 1952). This poses the question as to whether or not the activity of these animals is based on an unknown physiological regulatory mechanism. If such a mechanism exists, it may bring about an increase in activity of a water-deficient animal as a means of increasing its metabolic rate with a consequent increase in the formation of metabolic water. Conversely, augmentation of oxidation water would supposedly not be necessary if the animal had access to sufficient water in its diet.

The suggestion of a mechanism for increased formation of oxidation water might be strengthened if the activity of the animal were to cease when no water could be gained from it. This would be the case at the lowest atmospheric humidities. *Dipodomys merriami* was shown to go into negative water balance at atmospheric humidity below about 2.5 mg. H_2O/liter air (10 per cent relative humidity at 25° C.) (Schmidt-Nielsen and Schmidt-Nielsen, 1951).

In the present study, the activity of two species of kangaroo rats was measured by means of exercise wheels attached with Veeder mechanical counters. The

animals were allowed to exercise under controlled conditions of light, temperature, humidity, and moisture in their diet. Comparison was made of activity under conditions of moderate humidity while on a diet of dry grain alone, and under the same humidity but with drinking water added. A record of activity was also obtained from animals kept on a dry grain diet while at a very low humidity.

STOCKS OF ANIMALS AND HABITAT OF FORMS

The species used in this study were selected for similarity in body size while greatly differing in their respective habitats. The factors which determine the availability of water to and the loss of water from an animal vary distinctly from one habitat to another. Such differences influence distribution and abundance of some mammals and birds, and are matched by physiological and behavioristic adaptations (Chew, 1951; Salt, 1952). Variations in the ability to conserve water and in daily water requirements of different species can also be expected (Ross, 1930; Odum, 1944; Vorhies, 1945; Schmidt-Nielsen *et al.*, 1948; Lindeborg, 1952). *Dipodomys panamintinus* is found in the semi-arid Mojave desert where water conservation is of utmost importance for survival, and thus might be expected to vary in its activity and physiology from *D. morroensis*, which is restricted to a more humid seaside habitat where conservation may be of less significance in the maintenance of water balance (Table 1) (Grinnell, 1922).

TABLE 1.—*Macroclimate of* D. panamintinus *and* D. morroensis. *Relative humidity data cover a full year of observations, taken hourly during the night (8 PM through 8 AM). Weather stations located at Edwards Air Force Base, Kern County, and Santa Maria, San Luis Obispo County, Calif. Monthly temperature data, obtained for Morro Bay from Standard Oil Company Estro Terminal, are based on a 20-year average. Temperature data for the habitat of* D. panamintinus *are a 5-year average recorded at Palmdale (A.P.), Los Angeles County, Calif.*

Month	*Dipodomys panamintinus*						*Dipodomys morroensis*					
	Temperature, °F.			Rel. Humid., %			Temperature, °F.			Rel. Humid., %		
	Av. max.	Av. min.	Mean	Av. max.	Av. min.	Mean	Av. max.	Av. min.	Mean	Av. max.	Av. min.	Mean
Jan.	55	28	42	79	53	67	61	44	52	94	75	85
Feb.	62	33	47	74	45	60	61	45	53	88	58	75
Mar.	65	37	51	76	46	63	62	45	54	95	77	88
Apr.	75	50	59	71	42	59	64	46	55	98	83	91
May	81	50	65	67	42	55	65	48	56	91	64	80
June	89	56	72	62	39	51	65	50	58	95	74	89
July	98	63	80	45	29	37	66	52	59	94	81	89
Aug.	96	60	78	57	33	45	66	52	59	98	88	93
Sept.	93	57	74	54	29	43	68	52	60	96	83	91
Oct.	79	45	62	56	33	46	69	50	60	87	62	75
Nov.	68	35	52	75	46	60	67	48	57	94	65	82
Dec.	58	30	44	64	35	50	63	46	55	82	48	66
Annual	77	45	61	65	39	53	67	49	58	93	72	84

While the measurements of the macroclimate are of direct significance to man, who goes upright, breathes at a height of 1.5 meters and is continually changing his environment, it is of lesser importance in the life of the kangaroo rat, a nocturnal animal which spends its active hours on the ground, breathing at a height of a few inches, and confined in its travels to a small area. It seemed desirable, therefore, to determine further the climatic differences as they may occur on the microclimate level, in the natural habitats of *panamintinus* and *morroensis*. The following summary on microclimate is based upon readings from Geiger (1950).

Perhaps the most fundamental difference between the two habitats as it may affect the microclimate in these areas is the degree of plant cover. Since desert flora have a short growing season, reduced transpiratory water loss, and wide spacing of individuals, it is doubtful that the humidity near the ground will normally show any important nocturnal differences from that measured 2 meters above. Under circumstances unusual to a "semi-arid" desert, such as extreme heat and aridity, the absorptive powers of the dried soil tend to lower the humidity of the air just above it (Geiger, 1950: 97).

Where there is close plant cover, ground temperature lags behind air temperature. At night, because of the heat-transfer lag, the temperature at ground level would tend to be warmer; this would lower the relative humidity. However, the plant cover retains moisture evaporated from the soil and moisture emitted by the plants thru transpiration. This collection of water vapor along with the greater moisture-holding capacity of the warmer air, would tend to make the microclimate more humid.

In choosing particular animals most desirable for use, the age and sex of the specimens were carefully considered. In order to avoid the cyclic phenomenon in activity associated with estrous (Slonaker, 1924) as well as chronological variability (Slonaker, 1907) an attempt was made to secure for use only vigorous, fully grown adult males.

The range of *morroensis* is limited to less than 4 square miles, which area was used for mortar practice during World War II and is presently being further disturbed by grazing cattle. Extensive trapping revealed the scarcity of this species, necessitating the use of adults of both sexes.

Activity data obtained for females may be valid as an expression of the moisture conditions to which they were exposed, if the animals remained in a state of diestrous. The apparent absence in the literature of reports on the successful breeding of *Dipodomys* in captivity may be due in part to an inhibition of the normal estrual cycle. Known reports of successful rearing of kangaroo rats from birth, while in captivity, resulted from females that were pregnant at the time of their capture (Tappe, 1941; Doran, 1951).

It was decided that females of both species would be used, with their activity data presented separately from that of the males for comparative purposes.

MATERIALS AND METHODS

Recording wheels.—The activity-recording units employed in this study consisted of a wheel supported by an enclosing framework, a recording device, and a cage into which the exercising animal could retire. The wheel was constructed of a cylinder of ¼-in.-mesh galvanized wire cloth 6 ¾ in. in diameter, and 3 ¼ in. wide. Each end of the wheel shaft passed into a hole of slightly larger diameter which was bored into ¼-in.-wide steel bars. These bars were fastened to circular pieces of ¼-in. plywood whose sides completely enclosed the wheel and served as its support. Oil and light grease applied to the ends of the wheel shaft reduced friction between it and the supporting steel bars, and enabled the wheel to turn easily on its axis. In direct communication with the exercise wheel was a nesting box (8 in. × 4 in.) consisting of a mutual wooden base with a wire cover. The nesting area provided enough room for limited movement such as scratching about in the sand or rolling in the dust. However, all other activity performed for its own sake and not in the process of feeding or pelage care was necessarily expressed on the exercise wheel.

Temperature and humidity control.—All experiments were carried out inside a darkened 22-cu. ft. refrigerator. A heating element thermostatically regulated from the outside, working against a refrigerating unit, allowed for good temperature control (Table 2).

TABLE 2.—*Temperature and humidity conditions for all experimental series. Averages are based upon continuous daily records, with a minimum of 22 hrs. to the day*

SPECIES	TEMPERATURE, °C.			RELATIVE HUMIDITY, %			ABSOLUTE HUMIDITY
	Max. av.	Min. av.	Mean	Max. av.	Min. av.	Mean	Mean mg/H_2O/1.
panamintinus	25.3	24.8	25.0	62.5	56.0	59.0	13.6
	25.2	24.0	24.4	14.7	7.7	10.1	2.2
morroensis	25.4	24.7	25.0	67.2	58.2	62.4	14.4
	24.1	23.5	23.8	15.2	8.8	10.1	2.2

It was noted that when the constant-temperature chamber contained a full complement of test animals, it generally maintained a fairly constant humidity range of 55–65 per cent. Fluctuations depended in part upon the moisture in the outside air which was allowed to enter the chamber through a small opening and which was continually circulated throughout the box by the refrigerator fan. It was decided that this humidity range would be suitable for exercising the animals under moderate conditions. Humidity averages for this period are listed in Table 2.

In the experimental series carried out at low humidity, the caged test animals were placed in a large airtight aquarium (13 in. × 36 in. long) which was kept inside the constant-temperature chamber. Air was circulated through the

aquarium under pressure, variations in which were partially alleviated by bleeder valves. The volume of air passing through the system was measured by a flowmeter at from 4.2 to 4.5 liters per minute. One outlet allowed air to escape, while another was attached to a manometer which indicated air pressure inside the aquarium remained within normal limits. The air was dried by passing it through a series of five pyrex tubes, each measuring 29 mm. in diameter and 36 in. in length. The first four tubes contained anhydrous calcium chloride, with anhydrous magnesium perchlorate as the final drying agent. Trays of calcium chloride were placed inside the low-humidity chamber to aid in drying the air.

Temperature and humidity were measured by a recording hygrothermograph. The hair hygrometer is recognized as being deficient in its accuracy of measuring humidity at the extremes. However, it gives a continuous record and, with careful frequent checks, reliable results can be obtained.

Diet.—During an experimental series, the test animals were fed only pearled barley. This was chosen as the staple diet because the outer indigestible parts of the grain have been removed, thereby making it practical to ascertain the exact quantity consumed. Also, kangaroo rats were shown to thrive on a pearled barley diet (Schmidt-Nielsen and Schmidt-Nielsen, 1951).

The moisture content of pearled barley varies with the moisture of the air to which it is exposed. Barley used during the low-humidity series was dried for some months inside a large desiccator containing anhydrous calcium chloride. There was no need to alter radically the amount of free water contained in barley to be fed during the moderate humidity series, since the differences in the regulated humidity inside the constant-temperature chamber and the outside air were often slight. The amount of moisture in the barley was determined by drying previously weighed samples to constant weight, the difference in weight being that of the water lost. Once the moisture content for a sample of barley was known, it was stored in an airtight container. Before feeding this to animals, 20-gram portions were weighed out and kept for a minimum of 48 hrs. inside the regulated humidity chamber. This allowed ample time for the moisture in the grain to approximate that of the prevailing moisture in the air. The portions were then reweighed and adjusted to 20 grams, the change in weight representing the change in the moisture content of the food at the time of feeding. The average moisture content of the barley was 12.6 per cent (10.2–14.3) at moderate humidity and 6.6 per cent (6.5–6.8) at low humidity. A portion of 20 grams for two or three days' feeding was found to be in safe excess to that consumed.

When the moisture intake of an animal is restricted to that obtained from its food (either as free water or by the oxidation of its hydrogen content), the diet is considered as *dry*. When drinking water is added, the diet is called *wet*. Distilled water was used for drinking purposes so that the only value to be gained from it would be the water itself. Water was supplied to animals on wet diet *ad libitum*. The drop method was used, the water bottles having an 8-mm.-

tube opening which was shelved through firepolishing to inhibit dripping. Changes in the weight of these bottles, after correction for evaporation, satisfactorily measured the amount of water supposedly imbibed. When drinking, kangaroo rats usually grasped the water tube with the front paws and inserted their tongues in the tubular opening. On several occasions, they were observed licking water cupped in their front paws. The paws were then dried of excess water by rubbing in the sand. It is obvious that, in the latter case especially, the water taken was not the amount consumed. However, since all animals had equal opportunity to waste water, any resulting errors on water intake are believed to have balanced each other; data on water intake are presumed valid on a comparative basis.

General procedure.—Two days were generally allowed for the test animals to become accustomed to their respective cages and in the use of the exercise wheel. Prior to this, they were maintained for at least one week inside the refrigerator to acquaint them with the confines, the constant temperature, and associated operating disturbances. During the series at moderate humidity, animals were kept on a dry diet of pearled barley for a period of six or eight days. This was followed without interruption by a period of six days on wet diet in the low-humidity series. The animals exercised for six days while on a dry diet only.

The weights of the test animals, the amounts of water and food consumed, and the number of revolutions run by the exercising rats were usually recorded every two days. Care was taken to empty cheek pouches of the animals before weighing.

RESULTS

Activity at moderate humidity as influenced by moisture in the diet.—All individuals of the desert species decreased their activity when water was added to the diet (Table 3). The mean daily activity of *panamintinus* males decreased 45 per cent with a 33-fold increase in water intake. Females of this species showed a greater reduction in activity (64 per cent) while only availing themselves of seven times more water than they obtained on dry diet. The differences in activity on dry and wet diets were found to be statistically significant at the 1 per cent level for both sexes.

The coastal species showed no definite trend to reduce activity with increase in water intake; the males exhibited little change in activity regardless of diet, while females either increased or decreased their activity on wet diet, as compared to dry diet. As a group, activity of *morroensis* males or females does not appear to be much influenced by moisture in the diet.

There is little real difference in the mean daily activity of males and females of the same species except for *panamintinus* on wet diet. However, the desert forms were significantly more active than their sex counterparts of the coastal dwellers.

Comparison of activity under conditions of moderate and low humidity.—Under imposed dry dietary and humidity conditions, the mean daily activity of both species of kangaroo rats dropped considerably from that maintained by them when dry-fed at moderate humidity. The low activity levels exhibited by *panamintinus* under moist (moderate humidity, wet diet) and arid (low humidity, dry diet) conditions were approximately the same.

It should be noted that *morroensis* females No. 6 and 9 died in their activity cages during the last two days of the low humidity series. Therefore, their daily activity was calculated from the four days they lived to complete (Table 3).

The influence of experience upon activity.—Sumner (1932) noted a "fairly steady increase" in the day-to-day activity of *Peromyscus* as measured by recording wheels. Dice and Hoslett (1950), using the identical recording devices employed by Sumner, found the spontaneous activity of *Peromyscus* to increase rapidly during the first six days, after which the pattern became irregular with little further increase. The trend of increasing daily activity was ascribed to a gain in experience with the use of the exercise wheel. Experiments were carried out under uncontrolled laboratory conditions with animals having free access to food and water.

Activity data of five male kangaroo rats observed daily were examined to determine if experience may have influenced their use of the exercise wheels. With the exception of one animal which was not subjected to experimental conditions, all individuals were more active the first day than the second. The activity level reached by two individuals the first day was not matched by them any day thereafter. It would appear then that kangaroo rats are readily able to use the exercise wheel and that further experience is unnecessary. In emphasis of this, two individuals were given a few days opportunity to use recording wheels but failed to do so. When placed inside the wheel and prodded into activity, both ran in a short time with the speed and agility of a veteran. When left to their own devices for another day, the wheels were for all intents and purposes unused. This was clearly a case of non-acceptance of the wheel rather than the inability to use it.

Experience may influence a kangaroo rat's willingness to use an exercise wheel, provided that activity-compelling circumstances are not in operation. For example, Wald and Jackson (1944) have shown that the primary response of the white rat to dietary deprivation (i.e., restriction of water or food intake, or both) is increased running. Such appears to be the case with kangaroo rats in this study when their activity is compared on wet and water-restricted diets (Table 3). Precisely the same responses as those associated with variations in supply of bulk food or water have been found in rats deprived of thiamine (Guerrant and Dutcher, 1940) or the entire vitamin B complex (Bloomfield and Tainter, 1943).

An unbroken pattern of rapidly increasing activity the first four days by the one individual exercising under uncontrolled laboratory conditions probably cannot be explained as a response to a nutritional need. This animal was fed a

TABLE 3.—*Activity wheel records of kangaroo rats, under all experimental conditions of humidity and diet. Roman figures represent values obtained at moderate humidity (range 56–67 per cent); italic figures represent values taken at low humidity (range 8–15 per cent). One*

TABLE 3.—*Activity wheel records of kangaroo rats, under all experimental conditions of humidity and diet. Roman figures represent values obtained at moderate humidity (range 56–67 per cent); italic figures represent values taken at low humidity (range 8–15 per cent). One mile equals 3,102 turns of the exercise wheel*

SPECIES	ANIMAL NUMBER AND SEX	MOISTURE INTAKE GMS/100 GMS BODY WEIGHT		ACTIVITY/MILES/DAY					
				Dry Diet			Wet Diet		
		Dry Diet mean	Wet Diet mean	maximum av.	minimum av.	mean	maximum av.	minimum av.	mean
panamintinus	1♂	0.69	9.11	8.43	3.55	6.65	7.36	4.90	6.15
		0.13		*5.97*	*4.87*	*5.29*			
	2♂	1.16	41.37	5.57	3.06	3.81	2.09	0.50	1.28
		0.17		*1.23*	*0.40*	*0.81*			
	3♂	1.13	48.14	8.58	5.55	7.24	2.81	1.34	2.27
		0.28		*3.84*	*2.80*	*3.41*			
	4♀	0.82	8.41	4.84	4.18	4.52	2.46	0.30	1.41
		0.14		*1.77*	*1.13*	*1.48*			
	5♀	1.11	5.46	8.75	4.55	5.96	3.31	2.40	2.88
		0.34		*3.64*	*2.32*	*2.83*			
	6♀	1.01	8.44	6.99	2.35	5.15	2.08	1.04	1.35
		0.20		*4.99*	*1.83*	*3.57*			
morroensis	1♂	0.79	Died	5.98	5.00	5.49			
	2♂	0.31	28.29	2.86	2.43	2.70	3.23	1.76	2.60
		0.17		*1.80*	*0.46*	*0.95*			
	7♂	0.35	13.87	0.37	0.06	0.18	0.36	0.16	0.24
		0.07		*0.90*	*0.01*	*0.48*			
	10♂	—	—	—	—	—	—	—	—
		0.00		*2.17*	*0.01*	*0.86*			
	12♂	—	—	—	—	—	—	—	—
		0.18		*1.91*	*0.54*	*1.23*			
	3♀	0.23	20.52	1.62	1.08	1.34	0.56	0.05	0.29
		0.26		*2.71*	*1.60*	*2.32*			
	6♀	0.82	32.78	7.22	3.62	5.74	7.74	4.98	6.16
		0.03		*3.00*	*0.38*	*2.50*			
	9♀	0.62	13.75	1.79	0.94	1.50	3.57	1.34	2.50
		0.22		*2.27*	*0.83*	*1.55*			

mixture of seeds and had free access to water. That this was more than adequate in supplying bodily needs is evidenced by a gain of 6.5 per cent of initial body weight at the end of ten days on this diet. Since the activity of this individual was probably for the sake of exercise alone and not due to an overwhelming physiological need, the rising pattern of activity lends itself to an interpretation of the influence of experience.

DISCUSSION

When exposed to moderate humidity, *panamintinus* reduced its activity with the addition of water to the diet (Table 3). The trend appears to be one of decreasing activity with increasing amounts of water taken in. Individually and as a group, females drank less water than males but exhibited a greater reduction in activity. The estrous state of the exercising females was not determined. However, since the mean activity of males and females was fairly close at moderate humidity on dry diet, but significantly lower for females on wet diet, and similar again at low humidity, the sporadic difference in activity between the sexes appears due to the influence of the estrual phenomenon (Long and Evans, 1922; Wang, 1923; Slonaker, 1924). Or, estruation may have been greatly interfered with at times when the diet became inadequate (Slonaker and Card, 1923).

In spite of a lower activity level, the amount of water drunk by females is less than that of males (Table 3). Richter and Brailey (1929) found the total water intake of adult albino rats to be greater in males than females. The metabolic rate of females was higher than that of males, while the correlation between insensible water loss and surface area was the same for both sexes. If a similar condition exists in *Dipodomys*, there would be a higher rate of metabolic water production in females without any increase in evaporative water loss, which would reduce their need for drinking water.

The low activity level exhibited by *panamintinus* under moist conditions (moderate humidity, wet diet) was similarly maintained under relatively dry conditions (low humidity, dry diet) (Table 3). The results suggest the existence of some physiological regulatory mechanism which may increase the activity of water-deficient animals as a means of enhancing the formation of metabolic water. At humidities above the 10 per cent level at 25°C., desert kangaroo rats show a gain of body water (Schmidt-Nielsen and Schmidt-Nielsen, 1951). Such augmentation of metabolic water would be unnecessary when animals have access to sufficient drinking water, explaining the decrease in activity on wet diet in proportion to water intake. The formation of oxidative water requires oxygen and the necessary ventilation of the lungs involves evaporation of water. At humidities below the critical level, pulmonary evaporation exceeds the value of oxidation water (Schmidt-Nielsen and Schmidt-Nielsen, 1950*a*, *b*). Consequently, activity decreases since no water could be gained from it. Results to be presented in another paper show that the same individuals (*panamintinus*) under similar dry conditions lost less weight (and consumed less food) when in confinement than when allowed to exercise. Apparently activity was not

reduced enough under low humidity conditions to circumvent a rise in metabolic rate. Exercising animals would have been better able to conserve body weight by remaining entirely inactive, and thus reduce energy requirements and water loss. Therefore, if an activity control mechanism (related to the maintenance of water balance) does exist in *panamintinus*, it may be imperfectly developed or subject to modification by other factors.

The activity data obtained for *morroensis* were very erratic. However, this inconsistency may serve to strengthen the postulation of an activity control mechanism related to the maintenance of water balance. Such a physiological feature would be developed in animals in response to the demands of its environment. *D. morroensis* is normally subjected to relatively little evaporation due to the seaside location of its habitat (within California's fog belt) and dense vegetational growth in the area (Table 1). Conversely, *panamintinus* inhabits a "semi-arid" environment where plant cover is sparse and evaporative forces considerable (Table 1).

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SUMMARY

1. The influence of humidity in the air and water in the diet upon the spontaneous activity of kangaroo rats (*Dipodomys*) was measured by their use of exercise wheels.

2. At moderate humidity (mean 59 per cent) dry-fed *D. panamintinus* were hyperactive. With the addition of drinking water, activity decreased with increasing amounts of water taken. This decrease in activity was similarly maintained at low humidity (mean 10 per cent) on dry diet. The experiments suggest the existence of a mechanism for increasing formation of metabolic water (a) when there is a need for it, and (b) if the result is a gain in body water.

3. The activity response of *D. morroensis* to variations in humidity and moisture intake was very erratic; no definite trend was exhibited.

4. The difference in activity responses of the species appears related to the relative need for this physiological response for the maintenance of water balance in their natural environment.

5. Kangaroo rats usually learned to use exercise wheels the first day, and further experience was unnecessary.

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3109 Reservoir Drive, Simi, Calif. *Received July 26, 1956.*

GENERAL NOTES

ADDITIONAL RECORDS OF THE OHIO SHREW

The Ohio shrew, *Sorex cinereus ohioensis*, was described by Bole and Moulthrop (*Sci. Publ. Cleveland Mus. Nat. Hist.* 5(6): 89–95, 1942). They listed 181 records from eight counties of northeastern Ohio. The only records from Summit County, however, were from two owl pellets. Subsequently, Dexter (*Jour. Mamm.*, 27: 177, 1946) published the first complete specimen record from that county. Since then two other specimens have come to hand from Summit County and three from nearby Portage County. In the spring of 1950 the late Dr. R. C. Rush captured two male specimens at the Tamarack Nursery two miles north of Hudson. He reported observing these shrews on numerous occasions about the Hudson region over a period of many years, but was under the false impression that they were the pigmy shrew (*Microsorex hoyi*) because of their very small size. The two given to the writer measure 74 mm. in total length (with tail length of 30 mm.) and 81 mm. (with tail length of 32 mm.) respectively. These alcoholic specimens are now deposited in the U.S. F. & W. Serv. collections with accession Nos. 287759 and 287760.

A specimen was captured by Russell D. Foldessy at Spring Valley Nursery on November 2, 1948, 2.5 miles east of Hudson. This locality is just within the boundary of Streetsboro Township in Portage County. The stomach was empty upon dissection. On April 12, 1949, Mr. Foldessy's cat captured one and on October 8, 1953 his dog captured another. The latter had a total length of 84 mm. including a tail of 32 mm. in length. The other two were accidentally discarded before measurements were taken.

Probably this shrew, often no larger than the pigmy shrew and sharing with it the distinction of being the smallest mammal in North America, is common in the area, but not often are specimens captured. Acknowledgment is made to Dr. H. H. T. Jackson, formerly of the U.S. Fish and Wildlife Service, for checking the writer's determinations.—RALPH W. DEXTER, *Dept. of Biology, Kent State Univ., Kent, Ohio. Received November 19, 1956.*

ANOTHER DWARF SHREW FROM NEW MEXICO

On June 5, 1956, John Poorbaugh found a dead and desiccated specimen of the dwarf shrew, *Sorex nanus* Merriam, 2 miles east of Ruidoso, Lincoln County, New Mexico. The animal was discovered in a sink in a cabin in woods of spruce and fir. After soaking overnight in water the specimen was relaxed enough to permit taking of external measurements which are: total length, 82.0; tail vertebrae, 38.0; hind foot, 9.9 mm. Cranial measurements are as follows: condylobasal length, 14.4; palatal length, 5.9; least interorbital breadth, 2.6; maxillary breadth, 4.0; cranial breadth, 6.7; upper tooth-row excluding I^1, 5.1 mm. The specimen, of undetermined sex, catalog No. 1749 UNM, is preserved in the University of New Mexico Collection of Vertebrates.

The only other known specimen of *S. nanus* from New Mexico was obtained by Professor William J. Koster at Gallinas Creek, Sangre de Cristo Mountains, approximately 10 miles northwest of Las Vegas, San Miguel County (Koster, Jour. Mamm., 33: 250–51, 1952). The specimen here reported provides an extension of the known geographic range of the species of approximately 168 miles southward from the Sangre de Cristo Mountains.—JAMES S. FINDLEY AND JOHN POORBAUGH, *Dept. of Biology, Univ. of New Mexico, Albuquerque. Received October 27, 1956.*

THE HOG-NOSED BAT IN NEW MEXICO

On August 20, 1956, I captured a hog-nosed bat, *Choeronycteris mexicana* Tschudi, in Skeleton Canyon on the west side of the Peloncillo Mountains, 10 miles south of Rodeo, Hidalgo County, New Mexico, at an elevation of approximately 5,200 feet. The animal was

captured after dark as it flew about the inside of a small concrete cabin built into the side of the canyon wall. Vegetation on the canyon slopes included several species of *Yucca* and *Agave* as well as ocatillo (*Fouquieria splendens* Engl.). The bottom of the canyon contained a dry wash vegetated on the sides with evergreen oak (*Quercus* sp.), alligator juniper (*Juniperus pachyphloea* Torr.), manzanita (*Arctostaphylos* sp.), and other shrubs.

The specimen, a female, Catalog No. 1741 UNM, is preserved in the University of New Mexico Collection of Vertebrates. This species has been recorded by Cahalane from the Chiricahua Mountains in Arizona (Jour. Mamm., 20: 421, 1939) but, to my knowledge, this is the first specimen reported from New Mexico.—James S. Findley, *Dept. of Biology, Univ. of New Mexico, Albuquerque.* *Received October 27, 1956.*

ADDITIONAL TEXAS BAT RECORDS

Since the note by Eads *et al.* (Jour. Mamm., 37: 440, 1956) concerning new locality records obtained during Texas bat rabies studies, data have been obtained on two additional species of sufficient interest to warrant reporting. On September 12, 1956, a Mastiff bat, *Eumops perotis*, was submitted by Dr. Paul R. Weyerts, veterinarian, from Alpine, Texas. It had been captured alive and apparently without injury shortly after daybreak by Mr. L. C. Bradford at the furnace plant of the Fresno Mine in extreme southeastern Presidio County about 2 miles from the Brewster County line. The furnace operates 24 hours a day and it is probable that the bat was attracted by the numerous insects flying about the electric lights. This bat was placed in a paper sack ventilated with air holes and within two hours began to make loud noises, frothed at the mouth, went into convulsions and died within a matter of minutes. Although rabies was suspected, Negri bodies were not demonstrated in brain impression smears and the mouse inoculation test was negative.

Several species of bats are common in the vicinity of the mine; however, the employees had no recollection of ever seeing a Mastiff bat before. The only previous report of *E. perotis* in Texas known to us concerns the specimen taken in 1903 in Pumpville, Val Verde County (Taylor and Davis, Bull. 27, Texas Game and Fish Comm., 1947). Dr. W. W. Dalquest, Midwestern University, Wichita Falls, Texas, kindly confirmed our specific identification and gave us the opinion that on the basis of the single specimen, it should be referred subspecifically to *E. p. californicus*.

The second species to be treated here is *Lasiurus cinereus*. Since this bat is rarely reported from Texas, our records may be of value in plotting its migratory route in the state. An adult female was received April 16, 1956, from Mr. David Jameson, Texas Technological College, Lubbock. It had been taken alive in Lubbock several days previously and held in a cage. While handling it, Mr. Jameson was bitten and he submitted it for rabies examination. Tests were negative. A second adult female was received August 24, 1956 from Mr. Garlan Eastman at Seagraves in Gaines County. Rabies was not demonstrated. A third adult female was taken from Mrs. Edgar Perry's swimming pool in Austin, Texas, September 9, 1956, and it also proved negative for rabies.—R. B. Eads, J. E. Grimes and Mrs. Alice Conklin, *Texas State Dept. of Health, Austin.* *Received December 13, 1956.*

A NEW HOMING RECORD FOR THE LITTLE BROWN BAT

A short-term homing study of *Myotis lucifugus lucifugus* was conducted in Des Moines County, Iowa, during the months of July and August, 1956. Two bats, released 270 air miles from their home roost, were found back on the roost 17 and 22 days later, respectively. They were liberated in the northwestern corner of the state and returned to the southeastern corner, crossing over flat agricultural land and a number of small river valleys. The total number of bats released at this distance was 34, giving 5.9 per cent recovered. A previous homing record of *M. l. lucifugus* was 2.5 per cent recovered at a distance of 228 miles in 1 to 2 years (Smith and Hale, Jour. Mamm., 34: 122, 1953).

Thanks are due to John D. Mackenzie and Gretchen Mackenzie for assistance in banding and releasing these animals.—PETER SCHRAMM, *Museum of Vertebrate Zoology, Univ. of California, Berkeley 4. Received December 7, 1956.*

A RECORD OF *MYOTIS AUSTRORIPARIUS* FOR KENTUCKY

On January 14, 1956, Phillips collected a *Myotis austroriparius* a few yards inside the entrance to William's Cave, a small limestone cavern about 2 miles north of Hopkinsville, Christian County, Kentucky. It was hanging from the ceiling about 6 feet above the small stream that flowed over the cave floor. Upon comparison with material from Indiana, it proved referable to the race *mumfordi*, described by Rice (Quart. Jour. Fla. Acad. Sci., 18: 67–68. 1955). Although this species has been recorded from Arkansas, Illinois and Indiana, this appears to be the first record for Kentucky. The specimen, a male, prepared as skin and skull, is in Mumford's collection.—RICHARD E. PHILLIPS AND RUSSELL E. MUMFORD, *Dept. of Conservation, Cornell Univ., Ithaca, N. Y. and Univ. of Mich. Museum of Zoology, Ann Arbor. Received December 13, 1956.*

A YOUNG JAGUARUNDI IN CAPTIVITY

A young female jaguarundi, *Felis yagouaroundi*, was purchased in Veracruz, Mexico, by Charles M. Fugler, of Baton Rouge, Louisiana. Mr. Fugler kindly permitted me to rear this jaguarundi after we returned to the United States. The kitten was observed for two months at Lawrence, Douglas County, Kansas.

The kitten, when purchased on April 5, 1956, had the civet like body, relatively small head, and long, supple tail typical of adult jaguarundis. She was in the gray color phase but paler than adult pelage in the gray phase. Baird (Mammals *in* U.S. AND MEXICAN BOUNDARY SURVEY, 1859, p. 12) stated that the young is more rufous than the adult. Hair samples were taken from various parts of the body for color analysis. Individual hairs from the scalp, hind foot and dorsum were tipped with black, followed by a Chamois annulation, and then a Mummy Brown annulation (capitalized terms after Ridgway, COLOR STANDARDS AND COLOR NOMENCLATURE, 1912). The basal portion of some of these hairs was a pearl gray. Individual hairs from an adult jaguarundi in the gray phase (KU 2219) had two light and two dark annulations. Hairs from an adult in the red phase (KU 2220) had one or two light and two dark annulations. The vibrissae were not annulated and were white, black or Chamois. The kitten was measured and weighed weekly. Measurements (in mm.) taken on April 17 and May 25, were: total length, 510, 715; length of tail vertebrae, 200, 215; length of hind foot, 90, 112; ear from notch, 31, 39; weight, 975, 1,865 grams.

The kitten did not seem nervous and was friendly. She became irritable only if touched while she was eating and on the weekly automobile rides to the Museum of Natural History (where the measurements were taken. Her habits were cat like (like those of Siamese cats), especially her jumping prowess and affection. If neglected, as when I read, she would jump up on my lap or shoulders and go to sleep, purring softly. The kitten was kept in a cage in my absence and allowed the freedom of my apartment when I was present or disposed to watch her. She chirped, as described below, for approximately five minutes after being placed in this cage when I retired or left the apartment. The kitten did not scratch or attempt to escape on these occasions. When anyone was in her presence, however, she paced back and forth chirping loudly. She ran about the apartment for several minutes when released from the cage, as though enjoying her freedom. The kitten was more active at night, indicating a nocturnal instinct. She behaved in the daytime as she did at night but she tired quickly and seemed more lethargic.

Three different sounds were made: a chirping noise, a cough and a purring. The purring sound was like the purring of a domestic cat, but of a higher tone and more erratic rate. She

purred as she slept and while being stroked. The coughing sound may best be described as a throaty rattle, sometimes barely audible, as though air was forced from her lungs. The only times that I heard this sound were when she was pacing back and forth in her cage and once when I startled her. The chirping noise was a high-pitched birdlike sound. She made this sound when placed in her cage for the night, when I left the room, and as she fed. This chirping sound varied in volume and was more frequent as she ate than at other times.

The kitten displayed poor vision the first three weeks of observation. She bumped into objects and seemed to locate her food by smell. She was, however, able to perceive motion, especially at night or in a darkened room. Her vision improved and seemed normal after three weeks of observation.

We were awakened one night on the return trip from Veracruz by the loud, excited chirping of the kitten, then perhaps less than seven weeks old. We investigated and found that the kitten had practically finished eating a snake (*Leptodeira septentrionalis*) 12 inches long. The snake had escaped from a cloth bag in the night. We could not determine if the kitten attempted to chew the snake or had swallowed it whole. The kitten's teeth were small and it is more probable that she swallowed the snake whole. I began feeding the kitten raw beef liver and milk. Two weeks later I began feeding her raw horse meat and milk, supplemented with vitamin drops. She became excited as she ate and chirped warningly if a hand was placed near her dish or if she was touched. She ate until her belly was distended and was not lethargic afterward. She soon learned the significance of her dish and appeared instantly with an anticipant air if the dish was rattled on the floor. She dragged food from the dish to places underneath furniture, even at the opposite side of the apartment. Chopped horse meat seemed to curb this action. She was given freshly killed birds and small mammals on several occasions but seemed to prefer to play with them rather than eat them.

The kitten, without training, used a box of sand provided for defecation. She held her tail stiffly horizontal while defecating (and urinating) and did not cover the scats. Training did not persuade her to use the sand box for urination. She preferred, instead, to urinate on a small throw rug in a corner of the room.

The kitten's waking hours were devoted almost entirely to play. When playing by herself, she frolicked about the room, chasing her tail and climbing curtains and furniture. She carried an old fox tail about in her mouth with her head held unusually high, shaking the fox tail vigorously from time to time. She was always eager to play with me or anyone else. Some of the more common forms of play were: hugging a person's hand with her forelimbs and kicking vigorously with her hind feet (never attempting to scratch); hide-and-seek; jumping into my outstretched arms from the floor; bounding back into my arms (sometimes a leap of 6 feet) when thrown on a sofa; chasing objects drawn by a string; stalking in slow, deliberate movements. When she was ready to charge she lowered her head and breast to the floor with her back arched, held her tail horizontally with only the distal 3 inches twitching, adjusted her hind feet, and suddenly sprang. She tried to engage an old collie in play on several of her outings. Her attempts at play were clumsy, however, and the dog, seeming to be disturbed by such actions, did not cooperate.—WILLIAM L. CUTTER, *Museum of Natural History, Univ. Kansas, Lawrence.* *Received October 19, 1956.*

AMOUNT OF FOOD EATEN BY SMALL CARNIVORES

Bassariscus astutus.—An adult female ring-tailed cat was captured in a bakery in Madera, California. Mrs. Stella Garner kept it as a pet for two months before giving it to me for study at the San Joaquin Experimental Range. She fed the cat raisins, prunes and table scraps. She said it did not like bread but that it ate some cooked and fresh meats. The ringtail weighed 744 grams when I took it to the Experimental Range, but it soon gained and fluctuated between 900 and 1,000 grams on a diet of rodents and birds.

All food items fed the ring-tailed cat for nearly six months were weighed and the amount

consumed was ascertained. To determine daily consumption, a period of 44 days was selected. In that period the cat consumed 3,988 grams of rodents and birds for an average daily ration of 90.6 grams, which is about equal to 10 per cent of its body weight. Food was not always present in the cage, but additional food was added daily as needed.

The ringtail readily accepted its food either alive or dead, as long as putrefaction had not set in. It occasionally drank water. The ringtail readily consumed fur, feathers and bones. Even with ground squirrels (*Citellus beecheyi*), all but part of the tail was often consumed. Except for ground squirrels and pocket gophers (*Thomomys bottae*), all animals were usually eaten head first. Birds as large as brown towhees were completely devoured except for a few primary wing feathers. Snakes and lizards were not eaten as readily as birds and rodents, unless the ringtail had previously been on a diet of raisins only. Grasshoppers appeared to be relished.

At separate times a live female ground squirrel weighing 718 grams and a live male squirrel weighing 573 grams were put in the cage with the ring-tailed cat. The squirrels were not immediately killed but shared a small nest box with the ringtail. The female squirrel lived with the ringtail for eight days before she was presumably killed and then eaten.

Felis domestica.—A subadult male house cat weighing 1,642 grams was caged at the San Joaquin Experimental Range for 15 days. All of its food was weighed to determine daily intake. When released, the cat weighed 1,901 grams, a gain of 259 grams over its initial weight, which had been taken after a short period of restricted diet. Maximum weight following a large meal was 1,957 grams.

During the 15 days the house cat was caged, it consumed 2,696 grams of rodents and birds, for an average of 180 grams per day, which is equal to 9.5 per cent of its body weight. The greatest amount eaten at any one time was 17 mice (413 grams) in 26.5 hours. Except for two harvest mice (*Reithrodontomys*), all of the rodents fed the cat were laboratory mice (*Mus*). Birds used to feed the ringtail and house cat were brown and spotted towhee, white-crowned sparrow, oriole, jay and meadowlark collected as road kills and from various other sources.

The cat usually passed one or more scats at a time once a day, although two days were skipped entirely and feces were passed twice on three different days. Urination occurred once a day, but it was not necessarily associated with the passing of scats.

Mustela frenata xanthogenys.—An adult male long-tailed weasel was captured at the San Joaquin Experimental Range in a drift-fence funnel trap set for rodents and reptiles. During 388 days of weighed feeding, the weasel consumed 19,555 grams of food. Perhaps the animal would have consumed even more if food had always been available to it. While in a cold room (40° F.) for three months, the daily food intake was 77 grams, which is equal to one-third (33.5 per cent) of its body weight (230 grams). While in the animal room (66 to 86° F.) the weasel ate an average of 49 grams per day, or an amount equivalent to 21.3 per cent of its body weight.

The diet consisted exclusively of laboratory rats except for an occasional pocket gopher or some laboratory mice and part of one frog. Most animals were alive when fed to the weasel. He displayed no difficulty in killing rats that weighed as much or more than he did. After the weasel finished with each meal there usually was no evidence remaining of what it had eaten. The weasel generally consumed all of the hair, teeth, bones and viscera.—W. E. Howard, *Field Station Administration, Univ. California, Davis.* *Received October 15, 1956.*

MARTEN AND HAWK HARASS SNOWSHOE HARE

The incidents recorded here were witnessed in person on the White River National Forest, Garfield County, Colorado, at about 7:30 AM, October 15, 1956. This date was the opening of the regular big-game season, and I was hunting elk at the time of observation. The timber type was Engelmann spruce-alpine fir, at an elevation of about 10,500 feet. The spruce stand

had been killed by the Engelmann spruce beetle about 1948. A few inches of soft snow covered the ground.

At the time of the observation I was sitting at the edge of a small, irregularly shaped park which commanded a good view of the sedgegrass meadow attractive to feeding elk early in the morning. The nearest timber, other than immediately behind me, was directly in front but only about 100 feet distant. The drama that developed began when a red-tailed hawk, *Buteo jamaicensis*, circled at tree-top height over the park. Approximately three minutes later a marten, *Martes americana*, looped through the open timber in front, traveling on the ground and along logs. Seconds later a young snowshoe hare, *Lepus americanus*, in transition (bluish) color phase, flushed and ran down to the edge of the woods. The marten followed, rather leisurely it seemed; but when the predator neared the edge of the stand the hare hopped into the park and squatted under a small spruce about 20 feet from forest cover. The marten did not follow beyond the edge of timber. Almost immediately the hawk swooped down and alighted in the top of the 4-foot spruce sheltering the hare. The animal moved around under the tree, obviously disturbed by the wing-waving action of the hawk above. After a minute or so the hare darted back into the timber stand but, as the marten approached, it emerged and returned to the shelter of the small spruce. Flushing and return were repeated at least three times. It ended when the hare bolted down the edge of the park and disappeared in heavy timber 60 to 70 yards away. The hawk sailed off, and the marten retreated into the dead spruce stand.

Inspection of the trails left in the snow, a few minutes later, disclosed that the marten had trailed the hare for 30 or 40 yards. The marten track, clearly imprinted in the snow, was of characteristic size and spacing. There is no doubt of the identity of any of the three species involved. It would appear that the hare, in its escape strategy, took advantage of the marten's aversion to open range by crossing the 20-odd feet of grassland but, apparently, it could not cope with the threat offered by the hawk. Finally, the hare resorted to headlong flight in an effort to escape enemies attacking from both air and ground.

Appreciation is expressed to Dr. Lee E. Yeager who suggested this note and assisted in its preparation.—THOMAS R. WILLIAMS, *Colorado Cooperative Wildlife Research Unit, Colorado State Univ., Fort Collins.* *Received October 27, 1956.*

THE STATUS OF *EUTAMIAS MINIMUS JACKSONI*

In 1924, when Arthur H. Howell was studying chipmunks, I suggested to him that probably the members of the genus *Eutamias* from Wisconsin and northern Michigan were not *neglectus*, to which they were usually referred, but belonged to an undescribed subspecies. Accordingly, he named *Eutamias minimus jacksoni*, type locality Crescent Lake, Oneida County, Wisconsin, but went farther by placing *E. m. neglectus*, type locality Montreal River, eastern end of Lake Superior, Ontario, in synonymy under *E. m. borealis* (Howell, Jour. Mamm., 6: 53, 1925). He repeated in his final revision, and referred specimens from the eastern half of the Upper Peninsula of Michigan to *borealis* (Howell, North Amer. Fauna 52: 60, 1929). Burt says of Upper Peninsula *Eutamias*: "I am provisionally calling all of them *jacksoni*, although I suspect that when fresh topotypes of *neglectus* become available (Howell had no topotypes) future study may show that race to be valid and *jacksoni* to be a synonym of it." (Burt, Occas. Papers Mus. Zool. Univ. Mich., No. 481: 5, 1943).

Ten weeks after Burt's paper appeared, Anderson and Rand showed that specimens of *Eutamias* from the type region of *neglectus* were sufficiently different from *borealis* to recognize the subspecies *neglectus*. They placed *jacksoni* in synonymy under *neglectus*, and commented "that *jacksoni* is different is improbable, both from the original description and from the fact that Howell referred some western Ontario material (Lake Seul and Nipigon) to *jacksoni*" (Canad. Field Nat. 57: 134, 1944). Anderson and Rand, apparently, had never seen specimens from Wisconsin, Michigan or Minnesota! Peterson is conservatively non-

commital with: "It is the writer's conclusion that a more thorough study of *Eutamias minimus* in Ontario and Manitoba must be carried out before the ranges of the geographic races can be defined" (Contrib. Royal Ontario Mus. Zool. No. 37: 1, 1953). He indicates type localities of subspecies and range of the species east of Manitoba on a map (p. 3). Kellogg (*in* Miller and Kellogg, U.S. Nat. Mus. Bull. 205: 224, 1955), following the lead of Anderson and Rand, and apparently without examining pertinent specimens, places *jacksoni* in synonymy under *neglectus*.

In an attempt to clarify this problem I have studied 215 specimens of *jacksoni* from Wisconsin, including seven from the type locality and 47 others from within 40 miles thereof. I have also studied and compared 37 essential topotypes of *neglectus*, which came from the following localities in Algoma, Ontario: Coppermine Point, 1; Haviland Bay, 1; Kapuskasing, 5; Pancake Bay, 27; Schreiber, 3. The Ontario specimens are all in the National Museum of Canada. I express my gratitude and appreciation to Austin W. Cameron, National Museum of Canada, Ottawa, for the loan of this Canadian material.

As a result of this first comparison of essential topotypes of *neglectus* with topotypes of *jacksoni*, it is evident that the two forms are sufficiently different to be recognized as subspecifically distinct from each other; also, that both are subspecifically distinct from *E. m. borealis*. Compared with near topotypes of *E. m. neglectus*, Wisconsin specimens of *jacksoni* in comparable pelage show the following differences: Darker cheek and face lines; more ochraceous in the two median pale dorsal stripes; flanks distinctly brighter reddish ochraceous; ventral parts from chin to vent clearly white, as against pale smoke gray in *neglectus*; tail darker above, and underneath darker and brighter ochraceous; tail tends to be heavier and bushier. There is little difference in the measurements of the two forms although *jacksoni* averages slightly smaller than *neglectus*, the hind foot averaging about 1 mm. shorter. The skull of *jacksoni* averages relatively more slender than that of *neglectus*, the average ratio of greatest length to zygomatic breadth in 10 skulls of each subspecies being 1.80 in *jacksoni* to 1.73 in *neglectus*.—HARTLEY H. T. JACKSON, *U.S. National Museum, Washington 25, D.C.* *Received March 13, 1957.*

HOMING BEHAVIOR OF CHIPMUNKS IN CENTRAL NEW YORK

Homing movements ranging from about 150 to 700 yards have been recorded for *Tamias* by Seton (LIFE HISTORIES OF NORTHERN ANIMALS, vol. 1: 341, 1909), Allen (Bull. N. Y. State Mus., 314: 87, 1938), Burt (Misc. Publ. Mus. Zool. Univ. Mich., 45: 45, 1940), and Hamilton (AMERICAN MAMMALS, p. 283, 1939). While engaged in other studies during the summer of 1952, I had the opportunity of making additional observations on the homing behavior of the eastern chipmunk, *Tamias striatus lysteri* (Richardson), on the campus of Cornell University at Ithaca, Tompkins County, New York.

Live-trapping was conducted from July 26 to August 3 in a tract of approximately 3 acres of hemlock and mixed hardwood forest bordering a small artificial lake. A maximum of 12 traps was employed. The chipmunks taken were sexed, aged (subadult or adult), marked by clipping patches of fur on various parts of the body, and transported in a cloth bag to one of six release points. The latter were situated in similar continuous habitat or in an area of campus buildings, lawns, shrubbery, and widely spaced trees adjacent to the woodland. An individual was considered as having homed when it was retaken within 115 feet of the original point of capture. Those chipmunks that returned and were recaptured were immediately released again in a different direction and usually at a greater distance. First releases averaged 675 feet (310–1,160) and second ones, 1,015 feet (500–1,570). Two animals that returned after second removals were liberated for a third time at distances of 1,130 and 2,180 feet. All distances given are calculated from the station where the animal was originally trapped. Since the mean home range size of chipmunks in this vicinity has been calculated as about .28 acre (Yerger, Jour. Mamm., 34: 448–458, 1953), it is assumed

that in most, if not all, instances the removal distances involved were great enough to place the animal in unfamiliar territory beyond the boundaries of its normal range of movements.

A total of 18 individuals, consisting of five adult males, four adult females, two subadult males and seven subadult females, were marked and released a total of 29 times through July 30. Animals handled after this date are not included in the treatment of the data, since it is felt that there was insufficient opportunity for them to be retaken following their release. Seven of the chipmunks returned to the vicinity of original capture a total of ten times over distances varying from 430 to 1,200 and averaging 650 feet. In six of the ten returns the animals were retaken in the same trap in which they were initially caught. In two instances individuals were retrapped at stations 20 and 40 feet removed from the one where first taken, and in two others the individuals were recovered at a distance of 115 feet from the original site of capture.

Two adult males returned from 490 and 540 feet in two and three days, respectively, but were not recovered after second removals to 1,060 and 1,150 feet. Two other mature males trapped following their release at 310 and 750 feet had moved in a direction other than that of their original capture. An adult female was found in a trap a day after having been released at 775 feet. She returned a second time from 600 feet in two days. Another adult female was retrapped at the original trap station seven days following her release only 430 feet away. A single subadult male was recaptured in his original location the next day after his initial removal to 750 feet and two days after a second liberation at 1,200 feet. He was not retrapped subsequent to a third relocation 2,180 feet distant. Another young male was captured at a point 380 feet closer to its home area six days after being released 940 feet away. Three subadult females homed successfully. One returned from 580 feet the day after release, another from 650 feet in two days' time, and the third from 490 feet after an interval of five days. None were retaken following second liberations ranging from 940 to 1,570 feet. Two other subadult females were captured 100 and 120 feet closer to their original capture sites the day after having been released at 460 and 450 feet, respectively.

These limited data suggest that homing ability was restricted to rather short distances, only one individual being known to have returned from a point more than 775 feet away. The extent of these movements may be somewhat less than several reported by authors previously mentioned. However, because of the smaller home range size of chipmunks in this area as compared to other habitats in which the animals homed from more distant points, the actual distances moved over strange territory may be fairly comparable. The present results indicate no obvious differences in the proportion of adults and subadults homing nor in the average distance over which individuals in each of these age classes returned. The intervals of one to seven days between releases and recoveries, the relatively short distances involved, and the rather low proportion of returns (38.8 per cent) suggest that the animals may have returned to their home areas through random movements until familiar terrain was encountered. It should be mentioned, however, that the small number of traps employed might have been a factor in the low rate of recovery, since a chipmunk returning to its home region had a lower probability of being recaptured than would have been the case had more traps been present. This might also have tended to increase the apparent time taken to reach the home area following release. On the other hand, the use of a limited number of traps may have been advantageous in that there was less interference by traps with the normal activities and movements of the animals.—JAMES N. LAYNE, *Dept. of Biology, Univ. of Florida, Gainesville.* *Received December 1, 1956.*

THE PIGMY MOUSE IN SOUTHEASTERN ARIZONA

Recent trapping has resulted in a better understanding of the ecology and distribution of *Baiomys taylori* in Arizona. This species has been reported from only two localities in Arizona: 5 to 9 miles west of Hereford, Cochise County, where it was collected in "tall grass and weeds"

by Phillip M. Blossom in March, 1941, (Blossom and Burt, Occas. Pap. Mus. Zool. Univ. Mich., 465: 1–4, 1942), and 1 ½ miles southwest of Fort Grant, 4,600 ft., Graham County, where it was "taken in a habitat of mesquite, sacaton, yucca, grama, and some other low bushes" (Hoffmeister, Amer. Midland Nat., 55: 257–258, 1956). Specimens reported below indicate that this species is to be expected in local areas of dense grass throughout southeastern Arizona at elevations of 4,000 to 5,000 feet.

In November, 1955, and again in August, 1956, I collected a total of 49 pigmy mice at several localities in heavy grass (*Hilaria jamesii*) on a lava flow at 4,300 to 4,500 feet elevation, 5 to 20 miles north of the Mexican border and southeast of Chiricahua, a way station of the Southern Pacific railroad, in Cochise County. Here *Baiomys* was associated with *Peromyscus maniculatus, Perognathus flavus, Reithrodontomys montanus, Onychomys torridus, O. leucogaster, Sigmodon minimus,* and *Perognathus baileyi,* in order of decreasing abundance. *Dipodomys merriami* and *D. spectabilis* were taken from nearby areas of sparse grass. In August, 1956, in the Sulfur Springs Valley, 4 miles west of Pearce, 4,700 ft., Cochise County, I collected the pigmy mouse from a small strip of *Hilaria jamesii* approximately 30 yards wide and several times as long. *Perognathus flavus* and *Onychomys torridus* were also taken from the heavy grass at this locality, while the surrounding relatively bare areas yielded *Dipodomys merriami, Perognathus penicillatus, Onychomys torridus* and *Peromyscus* sp. *Baiomys* remains were found in barn owl pellets collected by E. Lendell Cockrum near Dos Cabezas, Cochise County, also in the Sulfur Springs Valley. In September, 1956, six pigmy mice were taken from mixed heavy grasses on the eastern alluvial fan of the Santa Rita mountains, 6 miles north of Sonoita, 4,600 ft., Pima County. The only other rodent trapped here was *Sigmodon minimus.* This locality represents a new northwestern limit to the ranges of both *Baiomys taylori* and *Sigmodon minimus.* At all these localities traps set in dense grass yielded more *Baiomys* than any other species of rodent.

In September, 1956, an attempt was made to obtain specimens for comparative purposes from the type locality of *Baiomys taylori ater* at Nicksville, 9 miles west of Hereford, 4,700 ft., Cochise County. Here 110 traps were set in heavy grass along the road to Hereford and in an ungrazed field just north of Nicksville. Although Blossom collected *Baiomys, Sigmodon minimus* and *S. hispidus* here in 1941, I obtained only *Sigmodon hispidus, Onychomys torridus* and *Perognathus baileyi.* Hoffmeister and Goodpaster (Illinois Biol. Monogr., 24(1), 1954) also failed to collect *Baiomys taylori* and *Sigmodon minimus* in this area in 1950, after approximately 600 trap-nights. I agree with their opinion that the grass appears dense enough to provide good cover for these rodents. Perhaps these two species were exterminated by a factor such as drought or overgrazing and have not re-invaded the area. The possibility exists, however, that some currently operating but unrecognized factor is preventing their re-establishment.

Grateful acknowledgment is made to E. Lendell Cockrum for his helpful guidance. I am indebted to Mont A. Cazier and to the American Museum of Natural History for providing the laboratory and housing facilities of the Southwestern Research Station, which served as a base of operations for much of the field work. This work was partially supported by a National Science Foundation predoctoral fellowship.—KEITH E. JUSTICE, *Dept. of Zoology, Univ. of Arizona, Tucson.* *Received December 24, 1956.*

RECORD OF THE MEXICAN HARVEST MOUSE (*REITHRODONTOMYS MEXICANUS*) FROM MICHOACÁN, MÉXICO

Mammal specimen No. 103295 in the University of Michigan Museum of Zoology is a harvest mouse (*Reithrodontomys mexicanus*) from Uruapan, Michoacán, México. It was recovered from the stomach of a snake (*Masticophis flagellum*) obtained by W. E. Duellman in Parque Nacional Barranca de Cupatitzio; the latter is situated on the outskirts of Uruapan. Duellman captured the snake early in the afternoon of 23 July 1955. It was found on the

ground near banana plants and trees. Digestion of the mouse had barely begun; its rufescent upper parts, dusky hind feet, monocolor tail and external dimensions were readily perceived.

Coalcomán, Michoacán, heretofore was the northernmost locality of occurrence of the species in western México (Hooper, Occ. Papers Mus. Zool. Univ. Mich., 565: 12, 1955). The present record extends the known range 85 miles to the northeast and into the main body of mountains that rim the Mesa Central.—EMMET T. HOOPER, *Univ. Mich. Museum of Zoology, Ann Arbor. Received November 19, 1956.*

SUPERNUMERARY TEETH IN *PEROMYSCUS TRUEI*

There are a few known instances of supernumerary cheek teeth in rodents (Hooper, Jour. Mamm., 36: 298–299, 1955). What these extra teeth signify—for example, whether they imply anything in regard to rodent phylogenies—is unknown. Their significance can be better estimated when there are many more examples on record and available for study.

A specimen of *Peromyscus truei* (Univ. Mich. Mus. Zool. No. 89142) from Distrito Federal, México, has four cheek teeth in each upper jaw. Each extra tooth is a single-rooted peg, 0.25 by 0.50 mm. in crown diameter. It is of occlusal height and it evidences normal wear. It is situated posterior to M^3 and in line with M^1 and M^2. To accommodate the extra tooth in the row, M^3, which is of normal size, is displaced slightly lingually, and M^1 and M^2 are slightly shorter (antero-posteriorly) than normal. The tooth row is no longer (4.3 mm.) than in other specimens from the area.—EMMET T. HOOPER, *Univ. Mich. Museum of Zoology, Ann Arbor. Received November 19, 1956.*

AN ADDITIONAL RECORD OF *REITHRODONTOMYS* IN ILLINOIS

On March 22 and 23, 1956, small mammal trapping in Whiteside County, 1 mile west of Denrock in northwestern Illinois, resulted in the capture of *Reithrodontomys*. The selected trapping sites included a railroad right-of-way and an adjacent bluegrass pasture which contained a dry marsh. The pasture contained numerous clumps of bluegrass and an occasional bull thistle. The dry marsh had a band of sedges and cattails around the perimeter with infrequent large clumps of marsh smartweed toward the center. The railroad right-of-way, which is burned each year during late March and early April, contained a rather dense growth of grasses and herbs which included little blue stem, wild rye, greater ragweed, wild asparagus, smartweed and goldenrod.

Five specimens of *Reithrodontomys megalotis* were taken during two nights of trapping representing a total of 60 trap-nights. The harvest mouse catch comprised 33.3 per cent of the total small mammals trapped which included *Blarina brevicauda* (1), *Peromyscus manículatus* (7) and *Microtus ochrogaster* (2). The distribution of the harvest mouse catch was as follows: Railroad right-of-way (3), open pasture (1), margin of marsh (1). A total of 150 trap-nights in the same area from June 26 to 28, 1956, yielded no further harvest mice.

The only previous *Reithrodontomys* from Illinois were reported by Hoffmeister and Warnock (Trans. Ill. Acad. Sci., 47: 161–164, 1955). Their catches were made at Mt. Carroll, Carroll County, which is about 30 miles north of the site represented by those herein reported. Hoffmeister and Warnock were not of the opinion that the Illinois race should be considered *pectoralis*, a new subspecies which Hanson (Field Mus. Nat. Hist. Publ. 564, Zool. Ser., 29: 205–209, 1944) established for southwestern Wisconsin and southeastern Minnesota forms. They preferred the subspecies *dychei* which occurs in eastern Iowa and Missouri. The pectoral spot, a tinge of pink and buff found between the forelimbs, the only character upon which Hanson based the new race, is considered by Hooper (Misc. Publ. Mus. Zool. Univ. Mich., 77: 1–255, 1952) as not being consistent in many of the *megalotis* groups.

The pectoral spot occurs only faintly in the five specimens from Whiteside County. In comparison with four Wisconsin specimens from Hanson's original collection (now deposited

at Southern Illinois University), the Whiteside County forms are less brown, being quite gray in appearance. Also, various body measurements are somewhat less than than those from both Wisconsin, Carroll County, Illinois (Hoffmeister and Warnock, 1955), and Kansas (Cockrum, Univ. Kansas Publ., Mus. Nat. Hist., 7: 1–303, 1952). Because of the small number of specimens available and the question of the validity of *pectoralis*, it would appear best to currently consider the Whiteside County specimens as representatives of *dychei*.

Skins and skulls are now deposited in the collection of the Cooperative Wildlife Research Laboratory, Southern Illinois University.—W. D. Klimstra, *Cooperative Wildlife Research Laboratory, Southern Illinois Univ., Carbondale. Received December 21, 1956.*

COMMUNAL LITTERS OF *PEROMYSCUS MANICULATUS*

Most authors agree that a female deer mouse with a young litter does not tolerate the presence of other adults in the same nest with her young (Dice, Jour. Mamm., 10: 116–124, 1929; Svihla, Misc. Publ. Mus. Zool. Univ. Mich., 24, 1932; Blair, Jour. Mamm., 22: 378–383, 1941). It is therefore worthy to record the finding of two females and eleven young occupying the same nest under natural conditions.

On May 8, 1956, at the Seyfang Ranch, 5 miles north of Toponas, Colorado, two adult females (*Peromyscus maniculatus*) were found in a single nest in the middle section of the knife-and-fork drawer in an abandoned house. Since males have been reported to assist females in tending young in the laboratory (Horner, Jour. Mamm., 28: 31–36, 1947), it was first presumed that this was a family group consisting of a male, a female, and their litter. Upon removal from the nest, young were observed fastened to the teats of both adults.

Eleven young mice were taken from the nest and all were approximately the same size and weight. It was impossible to separate the young into two groups on the basis of size or morphology. Their eyes were closed, vibrissae and bristles covered their otherwise naked bodies, and the dorsum of each was heavily pigmented with black. They were judged to be about one week old. Their weights ranged from 4.1 to 4.5 and averaged 4.32 grams.

The adult females were kept in separate cages while the young were weighed and photographed. The young were later returned to their original nest, the drawer replaced, and one female was released on the floor of the building. Within five minutes after release the female returned to the drawer and removed all eleven young to the next compartment of the drawer, although nesting material was absent in this compartment. The second female was then released and five minutes later both females were found hovering (as described by Huestis, Jour. Mamm., 23: 27–36, 1933) over the young. Some of the nesting material from the original nest site had already been transported to the nest compartment and arranged to form a nest. Two weeks later the nest was revisited and found unoccupied.

These observations indicate that occasionally two females may nest together and share in the care of each other's young.—Richard M. Hansen, *Colorado State Univ., Fort Collins. Received October 26, 1956.*

COLOR VARIATION IN POCKET GOPHERS, *THOMOMYS*

It has long been noted that the coloration of animals tends to correspond to the color of the soil they inhabit. Certain exceptions to this rule have been noted; however, as a general rule it seems to be fairly well accepted that there is a rather close correlation between the coloration of animals and that of the substrate (Dice and Blossom, 1937). This phenomenon has been best exemplified in comparisons of animals inhabiting lava fields with those from surrounding lighter soil. In this case the darker forms are limited to or at least are more abundant on the darker areas with the lighter forms being found on the lighter surrounding soil (e.g., Bradt, 1932; Hooper, 1941). Exceptions to this have been given by Sumner (1921).

In situations where lava flows are not involved one also finds differences in coloration of

the soils and again a general tendency for the coloration of the animals to match this background. Sumner (*ibid.*) first correlated directly development of lighter forms in desert areas with little rainfall and darker forms outside the desert areas with greater rainfall and/or humidity. He later (1932) indicated that this is probably not a true correlation and was supported in this view by Benson (1933). The correlation of coloration with amount of rainfall, however, appears to be an indirect one; greater rainfall normally produces a soil type containing more humus and, thus, darker.

A series of pocket gophers, genus *Thomomys*, in the collection of the University of Michigan Museum of Zoology, from southern Arizona and southeastern California seemed to provide material that might add information on the subject. In all, sixteen series were available from areas ranging in altitude from 8,800 feet in the Chiricahua Mountains to only 200 feet near Yuma. Also the series were all of the species *T. bottae* (based on Goldman, 1947). Going on the supposition that rainfall is greater at higher altitudes than at lower elevations, these series were examined to determine if any correlation existed between the color of substrate, as influenced by climate, and the degree of darkness in pigmentation of the pelages of these animals.

All measurements were taken with a Welch Densichron, using a Welch Densichron Reflection Unit No. 3832A, without filter. The reflection unit was clamped to a ringstand in an inverted position. A piece of glass plate was positioned so that it rested flush on the aperture of the light source. The Densichron was calibrated on Range 2 by utilizing a Gray Kodak Neutral Test Card (18 per cent reflection) and adjusting the meter to a reading of .20. The meter is graduated on a log scale and experimentation proved that this calibration allowed fullest possible use of the expanded portion of the scale with the extremes of coloration involved. The Densichron works on a reflection principle, and the readings obtained give an indication of the amount of light reflected by the pelage which in turn is an indication of its paleness or darkness. This, therefore, does not give a definitive value for each specimen, but does give a comparative reading based on a standard. The higher value represents darker coloration.

TABLE 1.—*Comparative color measurements of* Thomomys bottae *from southern Arizona and southeastern California*

LOCALITY	SUBSPECIES	COLOR VALUE	ALTITUDE IN FEET	NO. SPECIMENS
Cochise Co., Chiricahua Mts.	*collinus*	.95	8,800	8
Cochise Co., Chiricahua Mts.	*collinus*	.95	7,800	4
Cochise Co., Chiricahua Mts.	*collinus*	.95	7,000	5
Cochise Co., Chiricahua Mts.	*extenuatus*	.85	5,500	5
Cochise Co., Huachuca Mts.	*extenuatus*	.80	5,200	11
Cochise Co., Chiricahua Mts.	*extenuatus*	.80	5,000	6
Cochise Co., Willcox	*extenuatus*	.80	4,000	7
Pima Co., Arivaca	*modicus*	.80	4,000	11
Pima Co., La Osa	*modicus*	.80	4,000	9
Pima Co., Quintal Mts.	*pusillus*	.75	3,000	4
Pima Co., 4 mi. NE Sells	*comobabiensis*	.75	2,500	10
Pima Co., 11 mi. NW Sells	*comobabiensis*	.75	2,400	5
Pima Co., 6 mi. NW Covered Wells	*comobabiensis*	.70	2,200	4
Pima Co., Gunsight Ranch	*comobabiensis*	.70	1,900	8
Yuma Co., Yuma	*albatus*	.30	200	14
Imperial Co., Calif., near Yuma	*albatus*	.30	200	19

The skins were placed dorsal side down on the glass plate with the head in the direction of the light source. Just enough pressure was exerted on the skin to cause the hairs to lie flat on the glass plate. Since the reflection unit measures an area of only about 1/16 square inch, measurements were taken at three positions on the skin—between the shoulders, the middle of the back, and just in front of the rump. Again, because of the small area actually measured, three separate measurements were taken at each position and averaged. The readings from the three areas for each skin were then averaged to obtain a single measurement. Admittedly this system is not as desirable as one which would give a single value for the whole dorsal surface, but experimentation showed that rather constant values were obtained and it is assumed that fairly accurate measurements of paleness or darkness of pelage were obtained. The results of these measurements are shown in Table 1. (Note: Measurements were recorded to the nearest .02 for computation and the average for each series then rounded to the nearest .05).

As can be seen from Table 1, there is a general, while by no means conclusive, *trend* toward a color cline with the darker colored populations occurring at high altitudes, where rainfall is greater, and the paler populations at low elevations with less rainfall. This would appear to correspond to the theory that darker races occur in areas with higher rainfall and thus darker soil. These results parallel Hoffmeister's (1956) findings in the Graham Mountains. Indications of this same phenomenon were found in other areas of the west, but in no case were enough series available to obtain any conclusive evidence.

In a closely related group of certain animals (i.e., species), occupying a limited area in which the parent soil material is essentially the same, one would expect to find such a color cline. When populations of two or more closely related groups are considered together, this type of cline probably would not be apparent; in such a case, however, a cline should occur *within* each group. Also, in regions where factors other than rainfall are influencing substrate color, a cline would not normally occur.

In order to show the type of results one would expect to find where factors other than climatic conditions alone are involved, five series of *Thomomys bottae* from Valencia County, New Mexico, were examined. These were taken from a region in which out-croppings of lava occur (see Table 2). Here one can see a rather wide variation in coloration with only a slight difference in altitude (and thus rainfall) resulting from the action of the lava outcroppings upon the soil coloration. For a more detailed discussion of the mammals of this region, see Hooper (1940, 1941).

Appreciation is expressed to Mr. David E. Weyant of the Phoenix Memorial Project for loan of the Densichron and to Dr. W. H. Burt of the Museum of Zoology for suggestions in preparation of the manuscript.

TABLE 2.—*Comparative color measurements of* Thomomys bottae *from Valencia County, New Mexico*

LOCALITY	SUBSPECIES	COLOR VALUE	ALTITUDE IN FEET	NO. SPECIMENS
15 mi. SW Grants	*morulus*	.95	7,600	8
Shuman's Ranch	*collis*	.70	7,500	5
8 mi. SE Paxton	*morulus*	.90	7,400	10
1 ½ mi. SW San Mateo	*planorum*	.80	7,200	14
½ mi. N Cebolleto	*paguatae*	.70	6,700	11

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LOWELL L. GETZ, *Dept. Zoology, Univ. Michigan, Ann Arbor.* *Received September 12, 1956.*

THE YELLOW-HAIRED PORCUPINE AS A HIGHWAY CASUALTY

Stoner (*Jour. Mamm.*, 21: 360–361, 1940) called attention to the paucity of published records of the porcupine as a highway casualty. Only one record was published previous to his own and several others that he accumulated upon investigation of the Canada Porcupine (*Erethizon d. dorsatum*) as a highway casualty. A plea was made to record such cases. The writer found a yellow-haired porcupine (*E. dorsatum epixanthum*) which had been killed on the highway some 5 miles north of Leadville, Colorado, on Route 91. The body was still fresh when found at 9:30 AM on August 29, 1956.—RALPH W. DEXTER, *Dept. of Biology, Kent State University, Kent, Ohio.* *Received October 4, 1956.*

DISTRIBUTION OF PORCUPINE IN UPPER MICHIGAN

In 1954 an investigation of the distribution and ecology of the Canadian porcupine (*Erethizon dorsatum*) was initiated in the Upper Peninsula of Michigan. In studying distribution, data were collected by (1) summer census of trees damaged by winter feeding of porcupines and (2) a survey, at the Straits of Mackinac deer checking station on November 19 and 20, 1955, of deer hunters who had killed or seen porcupines.

The summer damage census was conducted in Gogebic, Ontonagon and Iron Counties at the western end of the Upper Peninsula. Trees damaged by porcupines were tallied per hour of survey time to give a damage index used to compare areas. The survey of deer hunters was conducted to determine the vegetation types in which hunters saw or killed porcupines. Hunters were asked the counties hunted, porcupines seen, porcupines killed, and the vegetation type in which these animals were located. Vegetation types were divided into swamp, hardwood, pine and "other" forests.

The summer damage index ranged from 0 to 2.4 trees tallied per hour of survey. The largest numbers of damaged trees were found in second-growth maple-hemlock forests.

Tamarack-spruce forests had only slight damage, while virgin hemlock, aspen forests and pine plantations had no evident damage. Hemlock appeared to be most heavily used by porcupine in winter feeding, with maple, basswood and tamarack also eaten.

The 1,060 deer hunters interviewed killed 29 and saw 309 porcupines. The deer-hunting success of this hunter sample was 24 per cent, compared with a success of 25 per cent for all hunters in the Upper Peninsula in 1955 (Mich. Dept. of Conserv., Deer Hunting Information, 1956). Because of the fairly close agreement of success in the hunter sample and in the total population of hunters it was assumed that the sample fairly represented all hunters.

Kill and sight records by vegetation types are shown below:

Vegetation type	*Hunters*	*Porcupines killed*	*Porcupines seen*
Swamp forest	410	11	109
Hardwood forest	518	13	176
Pine forest	108	5	24
Other	24	0	0

Under the assumption that the numbers of porcupines should follow the numbers of hunters, a chi-square test of homogeneity showed a highly significant difference for animals seen (resulting from an excess in the hardwood forest type) but with the smaller numbers of porcupine killed there was no significant difference. These data indicated that hardwood forest contained the largest numbers of visible porcupines. The data further suggest that in the Upper Peninsula of Michigan hunters are of slight importance as predators on porcupines.

The deer-hunter survey also gave some information on the density of porcupines. Extrapolating from the sample of 1,060 hunters and the over-all population of 115,110 hunters (Mich. Dept. of Conserv., Deer Hunting Information, 1956) a total of 3,140 porcupines may be estimated as killed and 35,300 as seen in the Upper Peninsula in 1955 by deer hunters (making no allowance for repeated sightings). Confidence limits at the 95 per cent level are 2,520 to 4,640 porcupines killed and 31,100 to 40,300 seen. Although the proportion of the porcupine population seen by hunters is unknown, sight records suggest a density of at least two porcupines per square mile over the entire Upper Peninsula. In specific localities population densities may be expected to reach a much higher level. Spencer (U. S. F. & W. Serv., Wildlife Leaflet 328, 1950) reported densities of one porcupine per 5 acres and Kelker (Jour. Wildl. Mgt., 7: 133–141, 1943) reported one porcupine per 1–26 acres in Wisconsin—FRANK B. GOLLEY, *Dept. Zoology, Michigan State Univ., East Lansing.* *Received October 18, 1956.*

METABOLISM OF VARYING HARE IN WINTER

It is of practical and theoretical interest to define the degree of cold at which warm-blooded animals must add to their basal rate of heat production. Scholander *et al.* (Biol. Bull., 99: 225–258, 1950) have described the procedure to be used in this definition and its basis. They have shown the temperatures causing the elevation of metabolism as a critical temperature in the metabolism of a number of arctic birds and mammals. The accumulation of information concerning metabolism and climate improves our comparative views of the adaptations by which animal heat production is suited to various climates. Accordingly we take the opportunity to record measurements indicative of the metabolism and critical temperature of an American varying hare, *Lepus americanus macfarlani* Merriam, captured near Anchorage, Alaska, in January, 1952.

The experiments were conducted on five alternate days. Thirteen days after its capture the hare died from unknown causes. Its condition during the experiments and the metabolic measurements were so regular that they appear normal.

Food was withheld from the hare during 15 hours before experimentation. The hare weighed between 1.31 and 1.45 kg., being heavier on the last day of experimentation. The

metabolic measurements were made by the open-circuit method as in our other studies (Physiol. Zool., 28: 173–185, 1955). Each period of air collection, represented by a point in Fig. 1, lasted 12 minutes. The respiratory quotients, for which the average measured at each temperature is recorded in the figure, are normal for a fasting but not for a starved herbivore.

The basal metabolic rate indicated in Fig. 1 is 0.68 ml/O_2/gram/hour. This is at the rate of 105 kilocalories/24 hrs., which is close to the rate found on the "mouse to elephant" curve relating metabolism to weight.

The critical temperature of our hare, i.e., that at which metabolism rose, was about –8° C. The insulation afforded by winter pelts of varying hares from arctic Alaska was found to be 2/3 that of the insulation of white foxes (Scholander *et al.*, op. cit.). Since the critical temperature of fur-bearing animals is commonly related to the insulation of their fur, it was suspected that arctic varying hares would have critical temperatures in winter higher than white foxes and above the arctic winter temperature which they generally encountered. At the northern limit of their range these hares obtain some shelter in their resting places in the willow brush to supplement the insulation of their bodies.

At Anchorage the mean temperature for January, 1952, was about –16°C. During winter a red fox and several porcupines at Anchorage had critical temperatures of –13 and –12°C. respectively. It appears that our hare was less well protected by insulation than these two heavier mammals which, however, had been captive for some time.

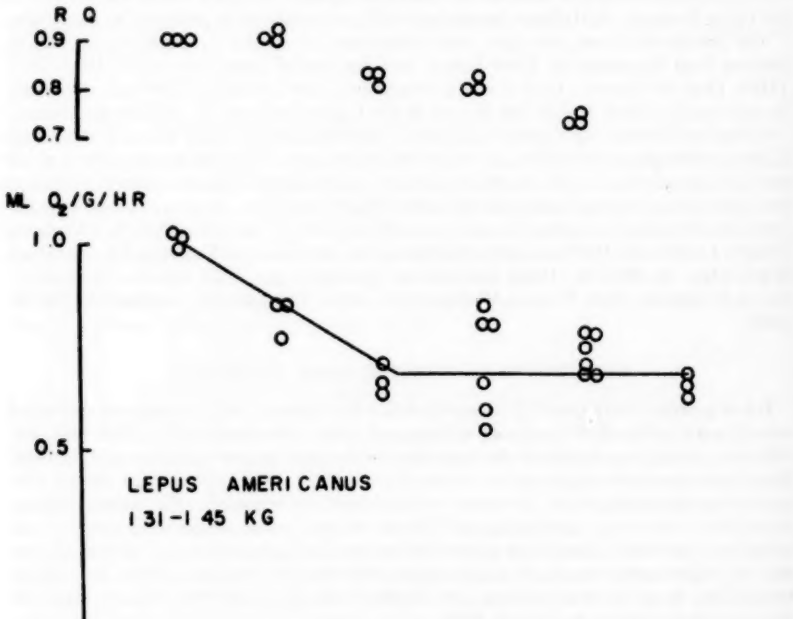

FIG. 1.—Respiratory quotients (above) and basal metabolic rates (below) of varying hare, plotted against temperature.

We suspect that the individual hare examined represents the common condition of the local hares. With the supplemental protection afforded by their habits, hares with a critical temperature about –8°C. could get along in the winter weather near Anchorage by expenditure of little more than basal metabolic energy for maintaining bodily heat. They can live in cold northern climates with the metabolic economy characteristic of the species, as has been found to be common among mammals which are adapted by insulation to their climate.—LAURENCE IRVING, JOHN KROG, HILDUR KROG AND MILDRED MONSON, *Arctic Health Research Center, Anchorage, Alaska.* *Received December 29, 1956.*

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U. S. WEATHER BUREAU CLIMATOLOGICAL DATA, ALASKA. 1952, 38 no. 13.

VARIATION IN LITTER SIZE OF NINE-BANDED ARMADILLOS

Due to the phenomenon of specific polyembryony, the nine-banded armadillo normally produces monovular quadruplets. One would expect that on occasion some variation in this number would occur. Intrauterine mishap would be expected to reduce the number of young born, and indeed this sometimes happens. Quite rarely one would expect to find more than four embryos in the uterus as a result of extra divisions of the embryonic disc at the time of implantation.

As a part of a study of reproduction in armadillos done in the biology department of the Rice Institute, Houston, Texas, some 60 gravid armadillos were examined. Two contained three embryos with no visible traces of a fourth. The uterus of one animal autopsied in the course of this study contained six normal embryos of 2.8 cm. head-rump length and an additional amniotic sac of about 1.5 cm. diameter.

The only other published record of fewer or more embryos than four is by H. H. Newman (Amer. Nat., 47: 513, 1913). In about 300 cases, he reported four sets of quintuplets, four sets of triplets (in which there was evidence of a fourth embryo having been resorbed), and one set of twins. Our finding of six embryos and the rudiment of a seventh appears to be the largest number recorded for *Dasypus novemcinctus*.

The writer is indebted to Dr. R. V. Talmage who directed the investigation during the course of which this material was obtained. The work was supported in part by a grant from the National Science Foundation.—G. D. BUCHANAN, *Dept. of Biology, Sam Houston State Teachers College, Huntsville, Texas.* *Received December 3, 1956.*

ADAPTATION OF SALT MARSH MAMMALS TO HIGH TIDES

Observations on the activities of mammals during tidal floods at San Pablo salt marsh, Richmond, Contra Costa County, California, were made in 1951, 1952 and 1955. Most evidence on behavior was gathered at the time of diurnal high tides in December; additional observations were made in late spring in the breeding season. At high tide the marsh is covered by 1 to 4 feet of water, depending on the height of the tide and position on the marsh. At these levels usually only 4 to 15 inches of vegetation is left exposed; most of this is *Grindelia cuneifolia*, a woody perennial growing as a dominant along elevated banks of tidal sloughs. Comparatively little *Salicornia ambigua*, dominant on medium to high

ground, or *Spartina foliosa*, a cordgrass dominant on low ground, is left uncovered. Since *Grindelia* grows along tidal sloughs, which twist and bend on themselves, the exposed tops at high water make an intricate pattern on the water surface. One important result of this is that floating debris is not allowed to be blown and moved only to the high edge of the marsh but is captured and held in place even in lower marsh areas. Many planks and timbers seen first on the marsh in 1950 were still in the same places in 1955, ten series of high tides later.

When floods occur mammals may either use emergent vegetation and floating debris as sanctuary or move to higher ground. The latter alternative, of importance on other marshes around San Francisco Bay as pointed out by Sibley (Condor, 57: 241–242, 1955), is not of significance on San Pablo marsh at any time; there is no high ground anywhere except on the periphery of the marsh, and this is too far removed from the centers of mammal populations on the marsh for most individuals to undertake movement to it. Thus, most of the mammal populations remain in nearly the same locations on the marsh during high tides as they occupied at low, moving only into emergent vegetation and debris.

This simple maneuver seems highly effective. Nowhere are animals exposed in large numbers. Occasional individuals may be seen swimming from one point to another, but in order to find many mammals the vegetation and debris must be searched thoroughly. This is not to say that high tides pose no problem in survival to mammals: young are drowned in the spring, and at any time of the year a few mammals are found (presumably) drowned after each series of high tides. Also, it seems that mortality due to predatory birds increases during high tidal conditions. Short-eared owls (*Asio flammeus*) and marsh hawks (*Circus cyaneus*) increase their foraging activities during high tides in winter (Sibley, *loc. cit.*; Johnston, Wilson Bull., 68: 91–102, 1956).

The following abbreviated species accounts list information on winter behavior and on responses to high tides, presumably adaptive, which have been made by the animals in the breeding season.

Sorex vagrans.—This shrew swims well at the surface or underwater; it dives readily when pursued by humans. Its coat does not get as wet as those of the other species mentioned here.

Of 45 occupied or empty nests of this shrew found on San Pablo marsh, only three were located at elevations less than 6 feet above mean sea level; all three eventually were flooded and the one that was occupied lost its litter of four young. Since this species builds its nests directly on the soil surface it is not surprising to find most nests placed on higher ground, where they may escape flooding.

Microtus californicus.—This meadow mouse is a strong swimmer at the surface and underwater and dives readily when pursued. Many individuals eluded capture by underwater swimming followed apparently by hiding in vegetation with only their noses above the water; the method was observed in three mice that did not escape. Underwater swimming was rarely longer than ten seconds, during which time an individual might cover up to 10 feet. A few mice were seen sitting on pieces of floating wood, drying in the sun and preening themselves; this was done with a great deal of seeming nonchalance.

No provision for meeting high tides during the breeding season has been made by this species. Nests always are placed on the soil surface and are found at all elevations on the marsh. However, breeding occurs from at least early spring to late fall; high tides occur in only a fraction of this time and presumably such floods cause losses insufficiently large to act as selective forces toward modifying breeding behavior.

Reithrodontomys raviventris.—Harvest mice did not swim as well as the other mammals; no diving or underwater swimming was seen. The fur of this species seemed to get wetter than that of the others and by and large these mice did not take to water readily when found hiding in the *Grindelia*.

Harvest mice most commonly place their nests above the ground surface on San Pablo marsh. Frequently they appropriate old song sparrow nests, roof them over, and raise a litter

in them. Song sparrow nests average about 10 inches above the soil surface. I have never seen a harvest mouse nest flooded.

Rattus norvegicus.—The Norway rat is the strongest surface and underwater swimmer and the most ready diver of all the mammals discussed here. It is the only species that has been seen to swim in the tidal sloughs at low water, both at and under the surface. Reasons for such swimming are not always clear. Once while sitting on a slough bank I saw a rat swim by me about a foot under the water surface for a distance of at least 4 feet; the water was only 2 feet deep.

Rats here usually place their nests on the ground. A notable exception was a spherical nest of woven *Spartina* leaves, 12 inches in diameter, hung 15 inches above the marsh surface in growing stalks of *Spartina*. This nest escaped floods in spite of being only 10 yards from the bayside edge of the marsh, and successfully housed a small litter and adult. Such architecture is not the rule, however, and high mortality to litters on the ground has been found. In two nests, among 30 young eight days of age and of strong appearance, only six remained after two successive high tides flooded them. Both adult females survived.—Richard F. Johnston, *Dept. of Biology, New Mexico College of Agriculture and Mechanic Arts, State College.* *Received November 30, 1956.*

A METHOD FOR DETERMINING THE ACTIVITY OF BURROWING MAMMALS

In connection with life history studies of burrowing rodents it has proven necessary to determine the extent of utilization of burrow systems in ground squirrel colonies. A simple, inexpensive technique was sought to measure which burrows or entrances to burrow systems were being utilized, as well as the time of utilization. The solution of the problem involved a small benzine lamp and sheets of coated paper. Both of these items are utilized in physiology laboratories for kymograph recordings. The paper is smoked in the field by holding desired lengths over the benzine lamp. The smoked paper is then rolled into a cylinder and inserted into the burrow entrance far enough to avoid its exposure to atmospheric moisture. The rolled paper can be stapled into a cylindrical form of desired size, but equally good results can be obtained by rolling the smoked paper into a cylinder slightly smaller than the burrow diameter and inserting it into the burrow entrance. Upon being released the paper springs open to form a tube completely surrounding the burrow passage. Periodic checks of the inserted papers show whether any animal has entered or left the burrow if footprints have been left on the smoky surface. Used papers can then be replaced to record activity for the following determined period. In addition to recording daily periodic use of burrows, longer time intervals can be employed in the absence of excess moisture as the smoked paper, particularly if previously waxed, stands up well under field conditions. This technique has proven valuable in determining the time of emergence of hibernating mammals as well as checking on their post-emergent activity.—William V. Mayer, *Dept. of Biology, Wayne State Univ., Detroit 2, Mich.* *Received October 29, 1956.*

MODIFICATION OF A LIVE-CATCH RODENT TRAP TO PROTECT SMALL MAMMALS

Small rodents, when confined in traps, are particularly vulnerable to extremes of heat, cold and moisture. The ultimate success of an ecological study involving the capture and release of small mammals often depends upon protection of mammals from these adverse conditions.

Plague ecology studies at the San Francisco Field Station involve repeated captures of rodents ranging in size from the comparatively large ground squirrels, *Citellus,* to the tiny harvest mice, *Reithrodontomys.* The smaller rodents such as *Microtus, Peromyscus, Reithrodontomys* and *Mus* are especially sensitive to the elements and must be protected from them until released. To meet this problem Young's Trap Model 15A (manufactured by Jack Phelps,

75 Starr Way, Mountain View, Calif.) was modified as shown in Fig. 1. Similar live-trap arrangements, tested by the Bureau of Animal Population, Oxford, England, have proved valuable in safeguarding small animals, as reported by Chitty (Jour. Anim. Ecol., 6: 36–53, 1937; Jour. Mamm., 19: 65–70, 1938; Ecology, 30: 536–542, 1949).

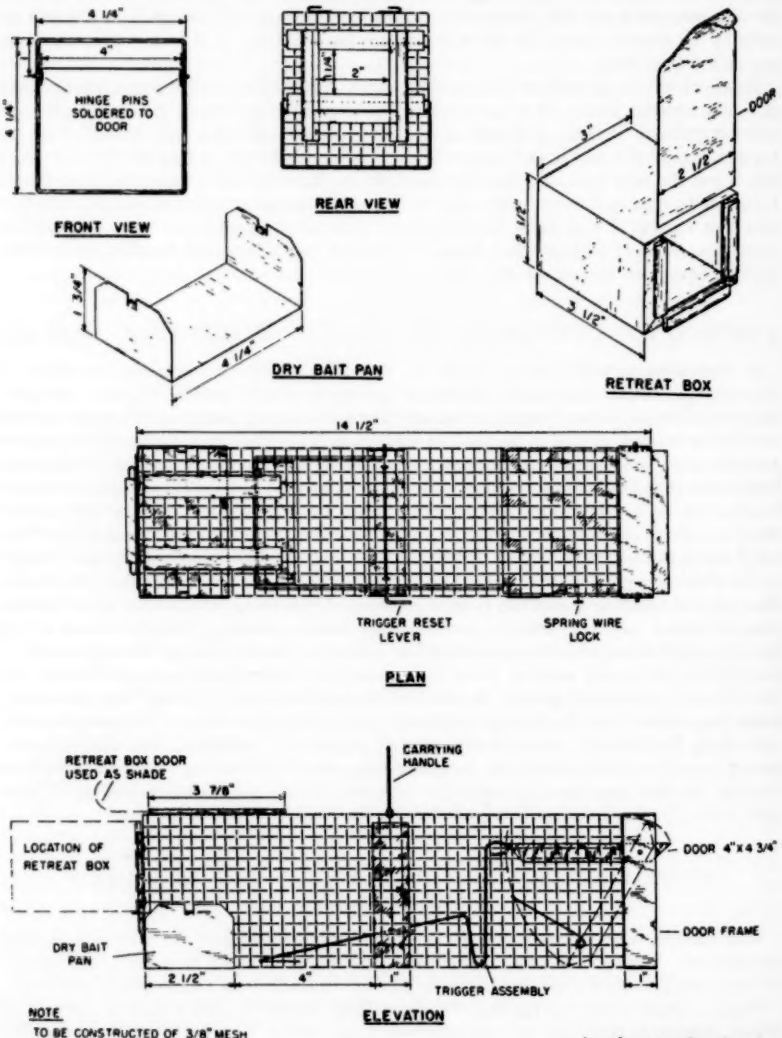


FIG. 1.—Modified Young's trap, model 15A.

The primary addition to the trap is a retreat box which provides shelter, bedding and shade. The open end of the box has double channels which slide over the flanges to attach the box to the rear of the trap. The inner channels receive the slide which closes the box when a rodent has been captured. The slide is held in place by channels on top of the trap over the bait pan until it is needed to close the retreat box. The slide is thus readily available and provides shelter. These grooves, attached to the top of the trap over the bait pan, secure the box in place and help provide shelter.

The retreat box is constructed of 20-gauge sheet metal and is bent to require only one soldered seam. Holes, 1/8 inch in diameter, are drilled in the bottom of the box for drainage. A ball of cotton is placed in the retreat box for bedding and protection of captured animals. The cotton also assists in preventing escape of ectoparasites which leave the animal. Small rodents caught in these traps in the field invariably hide in the retreat box. The slide may be easily inserted, the retreat box removed, and the uninjured rodent transferred to an etherizing jar. The cotton may then be placed in a white enamel pan and searched for ectoparasites. For trapping larger rodents, such as *Rattus norvegicus* or ground squirrels, a retreat box about 5 inches long is necessary.

A second modification of Young's trap is the attachment of a dry bait retainer to the bottom of the rear end of the trap. This precludes the use of a conventional bait container which often fouls the trigger treadle mechanism.—The modifications of the Young trap herein described are easily made with a minimum of skill and equipment. The extra effort to make these changes is more than repaid by the increased capture of uninjured mammals.—Alva R. Kinney, Dean H. Ecke and Virgil I. Miles, *Communicable Disease Center, U. S. Public Health Service, San Francisco, Calif.* *Received October 24, 1956.*

PERSONAL NOTICES

This space is available to members of the Society for brief notices of interest to mammalogists. Copy should be sent to the editor by the 10th of the month preceding publication. Rates for single insertion are 25 cents per line or portion thereof. Bills will be rendered following publication.

For Sale—*Japanese "Mist" Bat Nets.* Send for price list. W. B. Davis, 254 F. E., College Station, Texas.

Position Wanted—Mammalogist, M.A.; ecological, taxonomic and curatorial experience. Phillip M. Youngman, Mus. Nat. Hist., Univ. Kansas, Lawrence.

GLEANINGS FROM THE FIELD

It is our opinion that members would welcome brief word of the doings of others. We will be happy to present herein appropriate comments that come to our attention. New affiliations, projects undertaken, field trips planned are all of general interest.

At this date our gleanings are few. Recent (and not so recent) reports: A. W. Frank Banfield assumes the post of Chief Zoologist, Natural History Branch, National Museum of Canada at Ottawa; Don W. Hayne transfers as biometrician to the Institute for Fisheries Research at Ann Arbor; William V. Mayer takes over as Head, Department of Biology at Wayne State University, Detroit; John L. George joins the staff of the New York Zoological Society. Please forward your news items to the editor.

ZOOGEOGRAPHY

The Geographical Distribution of Animals

By Philip J. Darlington, Jr., Curator of Insects, Museum of Comparative Zoology, Harvard University. This basic zoogeography amasses facts, puts them together, and outlines the principles of geographical distribution of animals over the world. It is concerned only with the land and fresh water, and not the sea. It deals principally with the best known and geographically most significant animals—the vertebrates. The author stresses the importance of the tropics and treats the vertebrate faunas of South America and Australia in special detail—but all details are deliberately subordinated to the consideration of the world as a whole. The factual material is presented as a complete classification and list of families of existing land and fresh-water vertebrates, with distribution, pertinent fossil record, and other important information about each family. *1957. 675 pages. $15.00.*

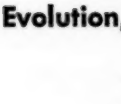
An Introduction to Genetic Statistics

By Oscar Kempthorne, Iowa State College. Offers a clear account of statistical problems and procedures in genetics. Surveys a large proportion of the mathematical and statistical material workers in pure and applied genetics need to understand those aspects of their field. A considerable portion of the work is devoted to quantitative inheritance, much of which has been developed only in the past four years by the author and by others. One of the Wiley Publications in Statistics, Walter A. Shewhart and S. S. Wilks, Editors. *1957. 545 pages. $12.75.*

Evolution, Genetics, and Man

By Theodosius Dobzhansky, Columbia University. ". . . as monumental as its writer. . . Once again Dobzhansky has done the kind of job we have come to expect of him, and a little more." —Carleton S. Coon, in *Human Biology. 1955. 398 pages. $5.50.*

Send for examination copies.



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REVIEWS

Haltenorth, Theodor and Werner Trense. BIG GAME OF THE WORLD AND ITS TROPHIES. Bayerischer Landwirtschaftsverlag GMBH, Bonn–München–Wien. Pp. xii + 436, 264 figs., 12 color pl., 6 maps. 1956. (In German, with English and French descriptions of the illustrations.) Cloth. Price DM 56.—($13.30).

As the reader is informed in the authors' foreword, this book has been written at the suggestion of the Counseil International de la Chasse (CIC), Paris, in order to meet the needs of persons whose field of interest includes the evaluation of trophies of big game animals. It is meant, therefore, in the first place for trained hunters and game wardens. Closer acquaintance with this work, however, indicates its usefulness to a wider range of people. It has been pointed out by the authors that the purpose of the book is not to stimulate the reckless killing of animals in a search for record specimens. Together with a standardization of the scoring system for trophies, they emphasize the necessity of better protection of game animals by informing the reader that the existence of a particular species is endangered. With these ideas in mind the authors have presented the material in the following chapters: Foreword; Big game and man; The history of the development of the evaluation of the trophies; The trophies in biological aspect; The big game of the world and the evaluation of its trophies; The systematic position of the big game; The preparation and care of the trophies; Bibliography (which includes mostly new, i.e., post-war literature); Major trophies of the world; Index.

With respect to the evaluation of trophies, the authors have incorporated in their work the new international scoring system, established at the CIC conference in Madrid in 1952, and the American system of the Boone and Crockett Club. These two systems have served also as a base for establishing methods for the evaluation of trophies of several Asiatic, Malay-Australian and South American animals, as well as sea animals, the scoring system for which has not been developed in the past.

The voluminous chapter "The big game of the world and the evaluation of its trophies" (it covers over two-thirds of the whole work) is of particular interest to students of mammalogy and to conservationists. In this chapter the authors list over 265 species of mammals with over 1,200 subspecies, providing brief information on distribution as well as on habits and habitats for each of them. Statements concerning the numbers of each subspecies show that the existence of about 280 forms is in danger. Recently extinct species and subspecies are also commented on by the authors. The chapter includes information on the present distribution and abundance of game animals introduced into different parts of the world. In addition to the mammals, attention is given to seven species of alligators, thirteen species of crocodiles and one gavial.

In the chapter on "Systematic position of big game animals," the principles of classification in the animal kingdom are presented on a level understandable by the layman. For persons interested in the appraisal of their bag, the list of the major trophies of the world will undoubtedly be a valuable addition, for the authors have given an account of the best trophies of numbers of game animals.

The reviewer wishes to suggest here a criticism dealing with a few cases of inconsistency in the sequence of listing of some species for different continents. Thus, in the European fauna, the authors present in the family Cervidae the roe deer (*Capreolus capreolus*) first, then the moose (*Alces alces*) and the reindeer (*Rangifer tarandus*) (pages 65–71). In the list of these species for Asia, the reindeer comes first, then the moose, and the last among the three is the roe deer (pages 137–139). The same kind of variation is found in connection with the wild goat (*Capra aegagrus*) and Siberian ibex (*Capra ibex*), as well as with two or three other species. In a geographical shift, Michigan's Upper Peninsula has been given to Wisconsin (map of North America, p. 287).

The reviewer finds it hard to agree with the authors' statement (on page 32) that the

antlers and horns of game animals, in addition to other functions, serve also as species characteristics within the association consisting of several species ("Neben Waffe und Werkzeug ist das Geweih und Gehörn ein Rangstuffenkennzeichen innerhalb eines Verbandes Gleichgearteter und ferner *auch ein Artkennzeichen innerhalb überartlicher Lebensgemeinschaften*") [The italics are the reviewer's]. However, this is a personal opinion and is not offered as a criticism.

The book is illustrated with excellent pen and ink drawings and with outstanding colored plates by Helmut Diller. The high quality of printing and binding makes the book very attractive.

On the whole, the work of Haltenorth and Trense, besides presenting for the first time an international scoring system for big game trophies, has contributed a great deal to our knowledge of the present status of big game in different parts of the world. It is likely to become a standard source of information in the field, especially if it is translated into other languages, and undoubtedly will be given a conspicuous place on the bookshelf of the hunter, game warden, game biologist and mammalogist.—W. Prychodko.

Beatty, R. A. Parthenogenesis and Polyploidy in Mammalian Development. Cambridge Monographs in Experimental Biology, No. 7. New York: Cambridge University Press. Pp. xi + 132, 5 figs., 1 plate. May 22, 1957. Price, $3.00.

Recent discoveries in the field of developmental biology have shown that the early mammalian embryo will tolerate a remarkable variety of chromosomal and cytological relationships. Parthenogenetic mammalian embryos can be developed from unfertilized eggs, germ cells need not be haploid or embryos diploid, and the interplay of cytological variables may lead to several alternative routes of development.

This monograph is a progress report of the research aims and results in this new and challenging field of investigation. The introduction is devoted to an outline of normal development of the eutherian mammalian egg, a discussion of definitions and terms, and a very brief presentation of chromosome preparation and counting techniques. The second chapter outlines sixteen major routes of mammalian development based on the possible occurrence of four cytological variables: (1) suppression of the first polar body, (2) suppression of the second polar body, (3) suppression of the first cleavage division, and (4) the genetic absence of spermatazoa.

Combinations of these variables offer the possibility of eight apomictic and eight amphimictic routes of development. Several of these routes are known to arise spontaneously in nonmammalian vertebrates and others have been demonstrated experimentally, although a few are yet unknown in vertebrates and are merely formal possibilities. In the second and third chapters, evidence for the spontaneous and experimentally induced occurrence of each of these routes in mammalian development is reviewed and summarized. Surprising progress has been made experimentaly with tetraploidy, triploidy and especially diploid parthenogenesis, for example. Through the use of various laboratory techniques, large numbers of parthenogenetic blastocycts have been produced and a total of five parthenogentic rabbits have been brought to term.

The fifth chapter examines kinds of development which do not fit into the proposed scheme of major routes. These are termed "minor routes," since they are of a heterogeneous nature and do not, collectively, form a unified body of knowledge; but the author freely acknowledges that some of them may be far from minor in importance. The phenomenon of chromosomal mosaics is given particular emphasis in this regard. The theory of genetic mutation is so universal that it is always possible to explain a mosaic by postulating appropriate changes and particular gene loci, although, as the author points out, gynandromorphs, intersexes and color mosaics in mammals might be equally well explained in terms of chromosomal mosaicism.

The sixth chapter discusses various aspects of parthenogenetic and polyploid development in mammals, and is especially interesting for its treatment of the genetic aspects of these phenomena and the possibilities of polyploid evolution and the occurrence of individual polyploids in natural populations. While the possibility of polyploid evolution in mammals is considered extremely remote, encouragement is given for the hypothesis that parthenogenetic individuals do occur, however rarely, in nature.

The last chapter presents an organized set of conclusions that are both cautious and provocative. While the book is too small to be more than a bare review of the evidence, the material is well documented and the author's thoughts on the subject are clearly presented.—RICHARD S. MILLER.

Jones, I. Chester. THE ADRENAL CORTEX. New York: Cambridge University Press. x + 316 pp., 35 figs., 9 pl. 1957. Price, $7.00.

This book was originally written to be included in the series of Cambridge Monographs in Experimental Biology. However, its final dimensions precluded such inclusion, so it was published as a separate volume.

The author, I. Chester Jones of the Department of Zoology, University of Liverpool, has done a remarkable job of boiling down a voluminous literature (over 1,100 references cited in this book), including his own extensive publications on the adrenal gland, and presenting it in a most readable and stimulating manner. The book begins with an extensive Chapter I (118 pages) entitled Eutheria. This chapter adequately covers such topics as gross anatomy, histology, adrenal steroid hormones, biosynthesis of cortical hormones, control of adrenocortical secretion, functions of the adrenal cortex, relationship of the cortex to peripheral tissue, adrenal-gonad relationships, and natural abnormalities of function. Then follow five chapters dealing with adrenal form and cortical function in the following vertebrate groups: Pisces, Amphibia, Reptilia, Aves, and Prototheria and Metatheria. Chapter VII describes the embryology of the cortex, and the final chapter is a discussion of the problem of the correlation of cortical structure and function. The illustrations and tables, including 45 photomicrographs, assist in summarizing, schematizing and illustrating conclusions, concepts and morphology. This reviewer considers the placing of the plates at the end of the respective chapters to be a disadvantage to the reader.

This book should prove to be of great interest and value to biologists and its reasonable price should make it available to many. It is well written and free of typographical errors. The careful reader will find not only statements of resolution but of stimulation and provocation.—KENNETH L. DUKE.

RECENT LITERATURE

(Prepared by the Committee on Bibliography)

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COMMENTS AND NEWS

HONORARIA

Two honoraria are available each year for young mammalogists who have not obtained the Ph.D. degree. These honoraria carry a stipend of $100.00 each to help defray the expenses of travel to the annual meetings for the presentation of the paper. In 1958 the meetings will be held in Tucson, Arizona, about the middle of June. Entries should be submitted to Dr. Stephen D. Durrant, Department of Zoology, University of Utah, Salt Lake City, Utah, before April 1, 1958.

RESOLUTIONS

Members having resolutions intended for action by the Society at its next annual meeting are urged to submit them to the Resolutions Committee at the earliest opportunity. The committee is anxious to submit the proposals to the members prior to the meeting but can do so only if they receive such proposals at an early date. May 1, 1958, has been set as a deadline. Proposed resolutions should be sent to the Committee Chairman, Dr. Keith R. Kelson, National Science Foundation, Washington 25, D. C.

RESEARCH GRANTS

The Division of Biological and Medical Sciences of the National Science Foundation announces that the next closing date for receipt of basic research proposals in the life sciences is January 15, 1958. Proposals received prior to that date will be reviewed at the Winter meetings of the Foundation's advisory panels and disposition will be made approximately four months following the closing date. Proposals received after the January 15, 1958, closing date will be reviewed following the Spring closing date of May 15, 1958. Inquiries should be addressed to National Science Foundation, Washington 25, D.C.

ARCTIC BIBLIOGRAPHY

Volume 7 of THE ARCTIC BIBLIOGRAPHY is now available for $4.25 from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. This volume abstracts 5,054 publications pertaining to all fields of research and resource development in the arctic and subarctic regions of America and Eurasia. Most of the entries are recent titles, up to the end of 1955. Still available are limited quantities of the previous six volumes, 1953–1956, each individually indexed.

ZOOLOGICAL NOMENCLATURE

Announcement has been received from Francis Hemming, Managing Director and Secretary to the International Trust for Zoological Nomenclature, of the forthcoming publication of the first installments of the OFFICIAL LISTS of valid zoological names and of the OFFICIAL INDEXES of invalid and rejected names. Categories covered in these volumes range from specific to ordinal names, and about 5,000 entries are contained in these initial installments. Volumes will normally deal with Classes but, in the case of large Classes containing well-recognized Orders, may be on an ordinal basis. Full alphabetical indexes will be provided, as well as indexes arranged by major groups. Since the entries in these works, promulgated from time to time by the International Commission on Zoological Nomenclature in individual "Opinions" and "Declarations," have become so numerous and involved as to make the checking of a particular name a difficult procedure, these official publications should be indispensable to all taxonomists in zoology and paleontology. It is felt that their appearance will constitute an important landmark in the struggle for securing stability in zoological nomenclature. All inquiries concerning these publications should be addressed to the International Trust for Zoological Nomenclature at its Publications Office (41 Queen's Gate, London S.W.7, England).

NORTHEAST WILDLIFE CONFERENCE

Canada will play host, for the first time, to the Northeast Wildlife Conference which meets at the Sheraton-Mount Royal Hotel, Montreal, on January 4–7, 1958. A gala program is planned for those interested in fish and game, conservation or natural history, and groups are expected from eleven States and six Provinces. Further details may be requested from the Chairman of the Conference, Dr. Gustave Prevost, at the University of Montreal, G 3, Montreal, P. Q.

PAYMENT OF DUES

According to our bylaws, annual dues are payable in advance for the calendar year. Mailing of the Journal to those in arrears on February 10 will be suspended with the next issue.

DEATHS REPORTED

Mary A. Bennett, August 13, 1957
William N. Beach, Charter Member, May 5, 1955
Edward A. Preble, Honorary and Charter Member, October 4, 1957
William Rowan, Emeritus Member, June 30, 1957
Karl P. Schmidt, Life Member, September 26, 1957

THIRTY-SEVENTH ANNUAL MEETING

THIRTY-SEVENTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

June 17–20, 1957

The thirty-seventh annual meeting of the American Society of Mammalogists was held at the Memorial Union Building, University of Kansas, Lawrence, June 17–20, 1957.

The Local Committee on arrangements was: E. Raymond Hall, Chairman, Sydney Anderson, James W. Bee, Frank B. Cross, William L. Cutter, Mary Dawson, DuWayne C. Englert, Henry S. Fitch, Edwin C. Galbraith, Robert M. Hedrick, J. Knox Jones, Jr., John M. Legler, Bernard C. Nelson, Philip W. Ogilvie, Robert L. Packard, Robert J. Russell, Ronald E. Smith, Terry A. Vaughan and Philip M. Youngman.

PROGRAM

MONDAY, JUNE 17

3:30–10:00 PM—Registration

8:00 PM—Directors' Meeting, Pine Room

Refreshments, Mammal Gallery, Museum

TUESDAY, JUNE 18

8:30 AM—Registration

9:00 AM—Morning Session

Welcome: John H. Nelson, Dean of the Graduate School, University of Kansas.
Response: William B. Davis, President, American Society of Mammalogists.

1. Home range and movements of the black-tailed jackrabbit. Robert R. Lechleitner, Colorado State University, Fort Collins.
2. The present status of exotic mammals in the United States. Clifford C. Presnall, U.S. Fish and Wildlife Service, Washington.
3. Consumption of food by *Microtus californicus*. E. W. Jameson, Jr., University of California, Davis.
4. The epithelio-chorial placenta of American moles. M. R. N. Prasad and H. W. Mossman, University of Wisconsin, Madison.
5. *Lasiurus borealis* and *L. cinereus* from Missouri caves. Richard F. Myers, University of Missouri, Columbia.
6. Sex ratios of some Minnesota rodents. James R. Beer, University of Minnesota, St. Paul.
7. Homing in bats. E. Lendell Cockrum, University of Arizona, Tucson.
8. Observations on Trinidad bats, with special reference to *Diaemus*, the white-spotted vampire. Arthur Greenhall, Port-of-Spain, Trinidad, B. W. I.
9. A traffic survey in *Microtus-Reithrodontomys* runways. Oliver P. Pearson, University of California, Berkeley.
10. Mammalogy in Cuba. Gilberto Silva-Taboada.

1:25 PM—Afternoon Session

11. A dynamic approach to mammalian taxonomy. Stephen D. Durrant, University of Utah, Salt Lake City.
12. The black wallaby (*Dorcopsis atrata*) of Goodenough Island, New Guinea. Hobart M. Van Deusen, American Museum of Natural History, New York.

13. Skins, skulls, and phylogeny. Luis de la Torre, University of Illinois, Urbana.
14. The systematic position of the South American tree porcupine, *Chaetomys*. Stuart O. Landry, University of Missouri School of Medicine, Columbia.
15. Genera of Recent mammals of the world. Ernest P. Walker, Washington, D. C.
16. Evolution of the giant squirrels and pigmy squirrels of the Indomalayan region. Joseph C. Moore, American Museum of Natural History, New York.
17. Relationship of *Thomomys talpoides-monticola* complex of pocket gophers in the Pacific Northwest. Murray L. Johnson, College of Puget Sound, Tacoma, Washington, and Seth B. Benson, University of California, Berkeley.
18. An analysis of intraspecific variation in the kangaroo rat, *Dipodomys merriami*. William Z. Lidicker, Jr., University of Illinois, Urbana.
19. Variation and its significance in the pocket mouse, *Perognathus parvus*. M. Raymond Lee, University of Utah, Salt Lake City.
20. Anatomical considerations in the taxonomic position of the genus *Lagurus*. Lyle C. Dearden, University of Southern California, Los Angeles.
21. The status of nutria in Florida. James V. Griffo, Jr., University of Florida, Gainesville.

6:30 PM—Buffet Supper, Kansas Room (Courtesy of Local Committee)

8:00 PM—Film, Hoch Auditorium—"The Wild Cattle of Cambodia," Charles W. Wharton

WEDNESDAY, JUNE 19

8:30 AM—Morning Session

22. The Tertiary history of heteromyid rodents. William G. Reeder, University of Wisconsin, Madison.
23. Vertebrate remains from archaeological sites in the Tennessee Valley of Alabama. F. S. Barkalow, North Carolina State College, Raleigh.
24. Behavior of the California pocket mouse, *Perognathus californicus* Merriam. Jean M. Linsdale, University of California, Hastings Reserve.
25. The use of dropping boards for population studies of small mammals. John T. Emlen, Jr., University of Wisconsin, Madison.
26. The lapping act in blood-feeding bats, family Desmodontidae. Bernardo Villa-R., University of Mexico, Mexico City.
27. Use of the calcaneum in studies of taxonomy and food habits. Howard J. Stains, Southern Illinois University, Carbondale.
28. A record of the Seminole bat, *Lasiurus seminolus*, from Oklahoma. Bryan P. Glass, Oklahoma State University, Stillwater.
29. Mammalogy in France. Jean Dorst.
30. Mammalogy in Germany. Theodor Haltenorth.

10:45 AM—Annual Business Meeting, Election of Officers

1:30 PM—Afternoon Session

31. Ecological distribution of five species of *Peromyscus* in central New Mexico. James S. Findley, University of New Mexico, Albuquerque.
32. Home range and dispersal activity in the wood mouse (*Apodemus sylvaticus*). Richard S. Miller, Colorado State University, Fort Collins.
33. The biology of the Abert squirrel in central Arizona. James O. Keith, Grand Junction, Colorado.
34. Past and present distribution of the marten in New York State. W. J. Hamilton, Jr., Cornell University, Ithaca, New York.

35. Reproduction in *Martes pennanti* in New York State. W. Robert Eadie, Cornell University, Ithaca, New York.
36. Reproductive behavior of the gray fox in southern Illinois. James N. Layne, University of Florida, Gainesville.

3:10 PM—Group Photograph

37. Notes on the yellow bat in Florida. William L. Jennings, University of Florida, Gainesville.
38. The influence of moonlight on success in trapping small rodents of different sexes. Keith E. Justice and Jack R. Hensley, University of Arizona, Tucson.
39. Ecology of the fox squirrel on the sandhills of northern Florida. Joseph C. Moore, American Museum of Natural History, New York.
40. Observations on the growth and behavior of the Australian brush-tailed possum (*Trichosuchus vulpecula*). B. Elizabeth Horner, Smith College, Northampton, Massachusetts.
41. Responses of various Australian mammals to hot atmospheres. Peter R. Morrison, University of Wisconsin, Madison.
42. Genital armatures in *Peromyscus*. Emmet T. Hooper, University of Michigan, Ann Arbor.

6:30 PM—Annual Banquet, Kansas Room

8:00 PM—Smoker, Museum

Film, "The Nature and Mammals of Greenland," Christian Vibe

9:00 PM—Informal Get-together, Flame Room, Dine-A-Mite Inn

THURSDAY, JUNE 20

8:30 AM—Symposium on Arctic Mammalogy

43. Live-trapping small mammals in winter in interior Alaska. William O. Pruitt, Jr., University of Pennsylvania (College, Alaska).
44. Problems of predator-prey relationships in Alaska. Robert F. Scott, U.S. Fish and Wildlife Service, Anchorage, Alaska. (Read by C. C. Presnall.)
45. Comparative structure of the digestive glands of hibernating and of active arctic ground squirrels, *Spermophilus undulatus*. William V. Mayer, University of Southern California, Los Angeles.
46. Further notes on *Phenacomys ungava* at Fort Churchill, Manitoba. J. B. Foster and Randolph L. Peterson, Royal Ontario Museum, Toronto.
47. A preliminary study of Ungava caribou. A. W. F. Banfield and J. S. Tener, Canadian Wildlife Service, Ottawa.
48. Observations on the reproductive cycle of the male arctic ground squirrel, *Spermophilus undulatus*. Ormond G. Mitchell, University of Southern California, Los Angeles. (This paper was awarded an honorarium.)
49. Aspects of coat color in young varying lemmings. Richard M. Hansen, Colorado State University, Fort Collins.
50. Geographic variation in the genus *Clethrionomys*, with special reference to *C. gapperi* in the Quebec Peninsula. Dale J. Osborn, Boston University, Boston.
51. The endemic land mammals of Kodiak Island, Alaska. W. Kim Clark, Kodiak.
52. The land mammals of Greenland in relation to climatic fluctuations. Chr. Vibe, Denmark.
53. The effects of environmental temperature and day-length on the reproductive organs of the collared lemming (*Dicrostonyx*). W. B. Quay, University of California, Berkeley.

1:30 PM—Final Business Meeting and Afternoon Session

54. Initial responses of small mammals to traps. John A. Sealander, University of Arkansas, Fayetteville.
55. Comparative movements of bobcats and coyotes as disclosed by tagging. Weldon B. Robinson, U.S. Fish and Wildlife Service, Denver.
56. Habits of the short-tailed shrew in captivity. John P. Rood, Kalamazoo, Michigan. (This paper was awarded an honorarium.)
57. Distribution of *Sorex dispar* in the northeastern United States. William J. Schaldach, Jr., University of Arizona, Tucson.
58. Additional returns from Mexican free-tailed bats banded in Oklahoma. Bryan P. Glass, Oklahoma State University, Stillwater.
59. Interrelations between black-tailed prairie dogs and grazing on the great plains. Carl Koford, Balboa, Canal Zone.
60. Parasitism in *Neotoma albigula* in southern Arizona. Jack R. Hensley, University of Arizona, Tucson.
61. The reproductive behavior of *Pipistrellus hesperus*. Philip H. Krutzsch, Southwestern School of Medicine, Dallas, Texas.
62. Infectious diseases in wild mammals at Dugway, Utah. Robert Holdenried, U.S. Public Health Service, Dugway Proving Ground.
63. Population dynamics of desert rodents in Indian Cove area, Joshua Tree National Monument. Robert M. Chew, Bernard B. Butterworth and Richard Grechman, University of Southern California, Los Angeles.
64. An analysis of motion in the running cheetah. Milton Hildebrand, University of California, Davis.
65. Banding studies of the Mexican free-tailed bat. Clyde Herreid II, Kerrville, Texas.

FRIDAY, JUNE 21

9:30 AM

Visit to the University of Kansas Natural History Reservation, Assoc. Prof. Henry S. Fitch in charge

or

Visit to the University of Kansas Experimental Fish Ponds, Asst. Prof. Frank B. Cross in charge

DIRECTORS' MEETING

The Board of Directors convened at 8:00 PM June 17, 1957, with all officers and directors present. Minutes of the previous Directors' meeting were read and approved. A list of 232 names was presented for election to membership and approved. When the President called for nominations for honorary membership some discussion developed concerning the significance of this category of membership, with the result that a permanent committee was authorized to consider such honors throughout the year, and to submit recommendations at each meeting. Burt (Chairman), Hamilton and Hall were named to the committee. Removal of 52 names from the rolls, for being delinquent in payment of dues for three years, was approved. The names of H. H. Lane and William Rowan were approved for emeritus membership, at their request. The resignations of 27 members were reported, and the Secretary was instructed to tender emeritus membership to others on the list who might qualify. The reports of the Treasurer and Auditors were presented and approved. The reports of the Editor and Corresponding Secretary were read and approved.

The following budget for 1957 was adopted, contingent upon the anticipated passage of the proposed amendments to the bylaws at the general business meeting:

Expenses of the Journal of Mammalogy	$10,000.00
Expenses of the Secretary-Treasurer	1,400.00
Expenses of the Editor	250.00
Expenses of the Membership Committee	50.00
Zoological Record	100.00
Honoraria for young mammalogists	200.00
Index Committee	200.00
Contingent Fund	240.00
Audit	70.00
Addressograph Machine purchase	410.00
Total	$12,920.00

The anticipated deficit was authorized to be taken from the cash reserves in the checking account of the Society.

Gregory was appointed to succeed himself as trustee. Transfer of $750.00 from the J. A. Allen Memorial Fund, and $2,250.00 from the Permanent Fund, to the Treasurer for the publication of the Journal was authorized. $2,234.94 from sale of back issues and life membership payments was transferred to the Trustees for investment. Action on selection of a meeting place for 1958 was deferred until the general business meeting. The matter of raising dues was brought up and tabled. The Editor and Secretary were authorized to initiate a personal advertising service for members in the Journal at their discretion.

SPECIAL MEETINGS OF BOARD OF DIRECTORS

A special meeting of the Directors was called at 3:35 PM June 19, 1957, after passage of the amendments to the bylaws at the first general session. Bryan P. Glass was appointed Secretary-Treasurer of the Society.

A second special session was convened a few moments later to discuss matters pertaining to the change in administrative procedure. The President was authorized to sign checks as well as the Secretary-Treasurer, in order to insure uninterrupted conduct of the affairs of the Society. Glass was authorized to make the transfer of the office of Treasurer and its records to Stillwater, Oklahoma, by the most expedient means, including if desirable a trip to Pittsburgh to check past methods and procedures and to return the files and records personally to the new executive office.

ANNUAL BUSINESS MEETING

The first session of the annual business meeting was called to order with 111 members present. Minutes of the previous meeting were read and approved. Reports of the Corresponding Secretary and Treasurer were read and approved. The auditing committee made its annual report which was also approved. The names of 232 nominees for membership were presented to the Society and unanimously elected.

The following summary of memberships and subscriptions was presented by the Corresponding Secretary:

Membership

Changes since last report:

Nominees		115
Resignations	29	
Deaths	11	
Members dropped (delinquent)	52	
	92	115
Net gain	23	

Status of Members as of December 31, 1956:

Honorary	10
Life	87
Annual	1,363
Total	1,460

Subscriptions

Changes since last report:

New		60
Cancelled	33	
	33	60
Net change	27	

Mailing List:

Total Membership	1,460
Members not receiving Journal	92
Members receiving Journal	1,368
Total paid subscriptions	497
Total mailing list	1,865

The deaths of eleven members, including honorary members (*) and charter members (†), were announced: Clarence Birdseye, F. A. Bryant, Ralph E. DeLury, E. R. Dunn, Dave Harris, Gerrit S. Miller Jr.*†, T. S. Palmer*†, Howard Robertson†, John W. Scott, G. B. Wislocki†, and Robert M. Yerkes†.

The order of business was altered so as to proceed with the proposed amendment to the bylaws. These were passed without opposition. The following officers were then elected: William B. Davis, President; Robert T. Orr and Stephen D. Durrant, Vice-Presidents; Randolph L. Peterson, Recording Secretary. Directors elected to the 1957–59 term were: Emmet T. Hooper, Keith R. Kelson, Oliver P. Pearson, J. Knox Jones, Jr., and Caroline A. Heppenstall.

The reports of the Editorial Committee and Committee on Honoraria were read and approved. Durrant announced that this year's winners were Ormond G. Mitchell and John P. Rood. Reports from the Index Committee and Membership Committee were read and approved. Special thanks to A. R. Shadle, chairman of the Membership Committee, who was not present due to illness, was expressed publicly on behalf of the Society. Reports from the Committee on Marine Mammals and the Committee on Nomenclature were presented and approved.

At the final business session at 1:30 PM, June 20, 104 members were present. The report of the Board of Directors was read and approved. The report of the Committee on Conservation of Land Mammals was read and approved. Late reports were also heard concerning the Wichita Mountains Wildlife Refuge and concerning the situation regarding bears in Alaska.

Tucson, Arizona, was selected as the site for the 1958 meeting, the time to be in mid-June.

Reports of the representative to the A.A.A.S., and of the representative to the National Research Council, were read and approved.

The following resolutions were presented to the Society and adopted:

WHEREAS, The barren-ground caribou is an important natural resource of northern Canada, and

WHEREAS, The continued well-being of many Eskimo and Indian bands in remote areas is dependent upon continuing supplies of caribou, and

WHEREAS, There has been a serious decline in the caribou population, and

WHEREAS, The Canadian Department of Northern Affairs and Natural Resources has commenced an intensive research program to study caribou populations; therefore be it

Resolved, That the American Society of Mammalogists commends the Minister of Northern Affairs and Natural Resources for recognizing the serious situation and for initiating the cooperative program that may lead to a better management of its caribou herds.

WHEREAS, The American Society of Mammalogists recognizes the scientific, philosophical and recreational value of wilderness areas, and

WHEREAS, The American Society of Mammalogists has in the past supported the establishment of wilderness areas, and

WHEREAS, The northeastern Alaska region encompasses one of the last remaining areas of wilderness under the jurisdiction of the United States; therefore be it

Resolved, That the American Society of Mammalogists commends the efforts of those individuals and organizations who are endeavoring to establish a wilderness area in northeastern Alaska; and be it further

Resolved, That the American Society of Mammalogists urges the Bureau of Land Management, the Secretary of the Interior and other Government agencies and officials to do all within their powers to aid in the establishment of a wilderness area in northeastern Alaska.

WHEREAS, Miss Caroline A. Heppenstall, outgoing Treasurer of the American Society of Mammalogists, has performed the many trying and difficult duties of that office in a truly excellent manner and has thereby very materially contributed to the well-being of the Society; therefore be it

Resolved, That the Society, on the occasion of its thirty-seventh annual meeting, extends to Miss Heppenstall the expression of deepest appreciation and gratitude.

WHEREAS, The University of Kansas and various members of its staff, by providing facilities, entertainment, magnificent hospitality, with untiring diligence, and especially for being instrumental in obtaining the participation of honored guests from foreign nations, have contributed greatly to the success of the thirty-seventh Annual Meeting of the American Society of Mammalogists in session at Lawrence, Kansas, June 17–20, 1957; therefore be it

Resolved, That the Society extends an expression of its sincere thanks and hearty appreciation to the University of Kansas, especially to Dr. E. Raymond Hall, Chairman of the Zoology Department, Director of the Museum of Natural History and Chairman of the Local Committee, and to other members of the Committee; and be it also

Resolved, That the participation of foreign scientists having been such a salutary part of the activities, those responsible for the organization of future meetings are encouraged to arrange for the continued participation of foreign scientists.

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